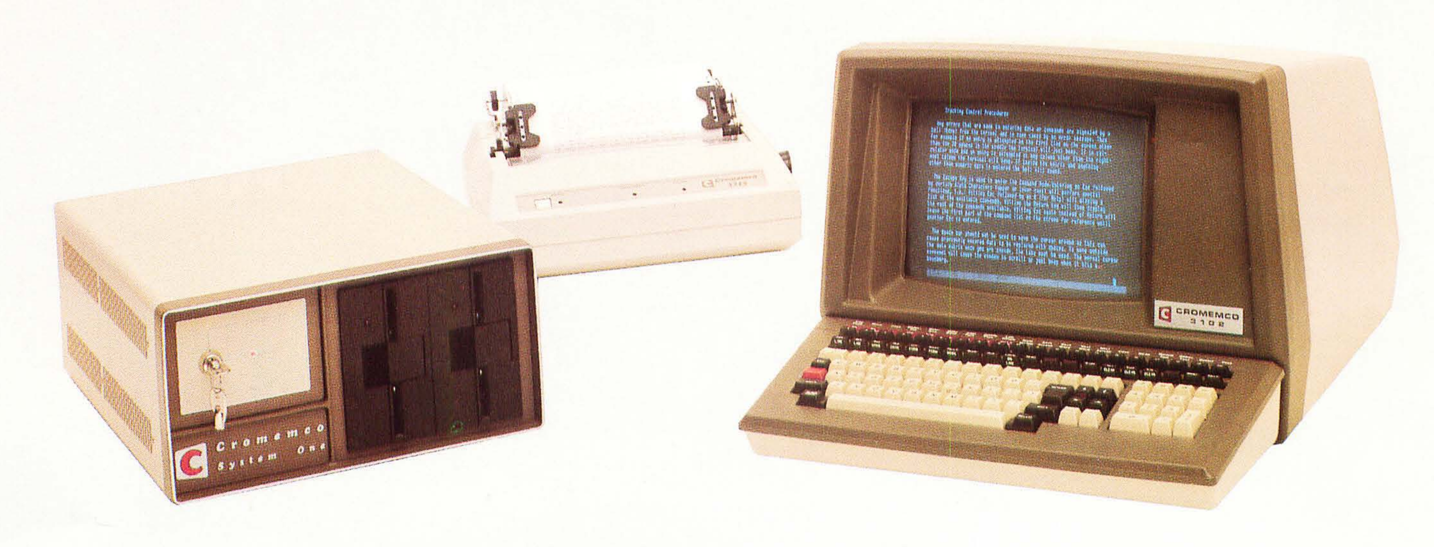
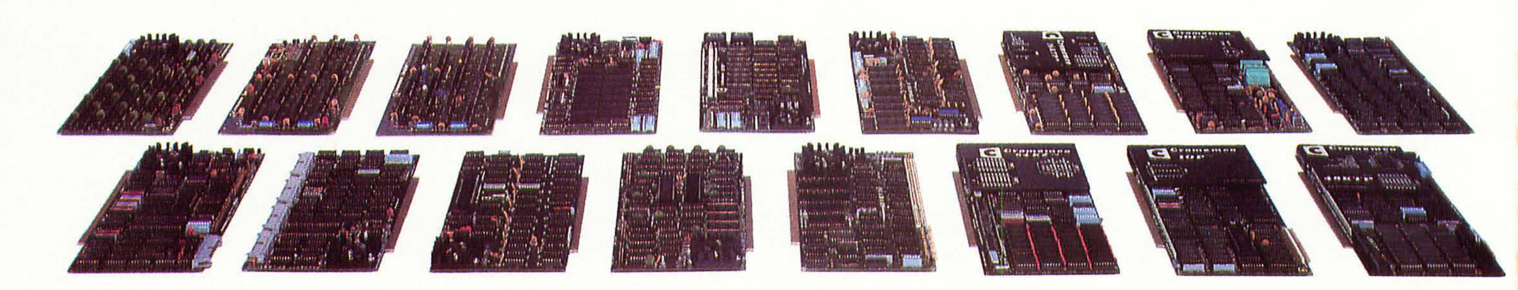

BYTE®
MARCH 1982 Vol. 7, No. 3
$2.95 in USA/$3.50 in Canada
A McGraw-Hill Publication
the small systems journal
Printers

A new small computer that won't limit you tomorrow



New Cromemco System One shown with our high-capability terminal and printer.



Expandability

Here's a low-priced computer that won't run out of memory capacity or expandability halfway through your project.

Typically, computer usage tends to grow, requiring more capability, more memory, more storage. Without a lot of capability and expandability, your computer can be obsolete from the start.

The new System One is a real building-block machine. It has capability and expandability by the carload.

Look at these features:

- **Z80-A processor**
- **64K of RAM**
- **780K of disk storage**
- **CRT and printer interfaces**
- **Eight S-100 card slots, allowing expansion with**
  - **color graphics**
  - **additional memory**
  - **additional interfaces for telecommunications, data acquisition, etc.**
- **Small size**

GENEROUS DISK STORAGE

The 780K of disk storage in the System One Model CS-1 is much greater than what is typically available in small computers. But here, too, you have a choice since a second version, Model CS-1H, has a 5″ Winchester drive that gives you **5 megabytes** of disk storage.

MULTI-USER, MULTI-TASKING CAPABILITY

Believe it or not, this new computer even offers multi-user capability when used with our advanced CROMIX* operating system option. Not only does this outstanding O/S support multiple users on this computer but does so with powerful features like multiple directories, file protection and record level lock. CROMIX lets you run multiple jobs as well.

In addition to our highly-acclaimed CROMIX, there is our CDOS*. This is an enhanced CP/M† type system designed for single-user applications. CP/M and a wealth of CP/M-compatible software are also available for the new System One through third-party vendors.

COLOR GRAPHICS/WORD PROCESSING

This small computer even gives you the option of outstanding high-resolution color graphics with our Model SDI interface and two-port RAM cards.

Then there's our tremendously wide range of Cromemco software including packages for word processing, business, and much more, all usable with the new System One.

ANTI-OBSOLESCENCE/LOW-PRICED

As you can see, the new One offers you a lot of performance. It's obviously designed with anti-obsolescence in mind.

What's more, it's priced at only $3,995. That's considerably less than many machines with much less capability. And it's not that much more than many machines that have little or nothing in the way of expandability.

Physically, the One is small — 7″ high. And it's all-metal in construction. It's only 14⅛″ wide, ideal for desk top use. A rack mount option is also available.

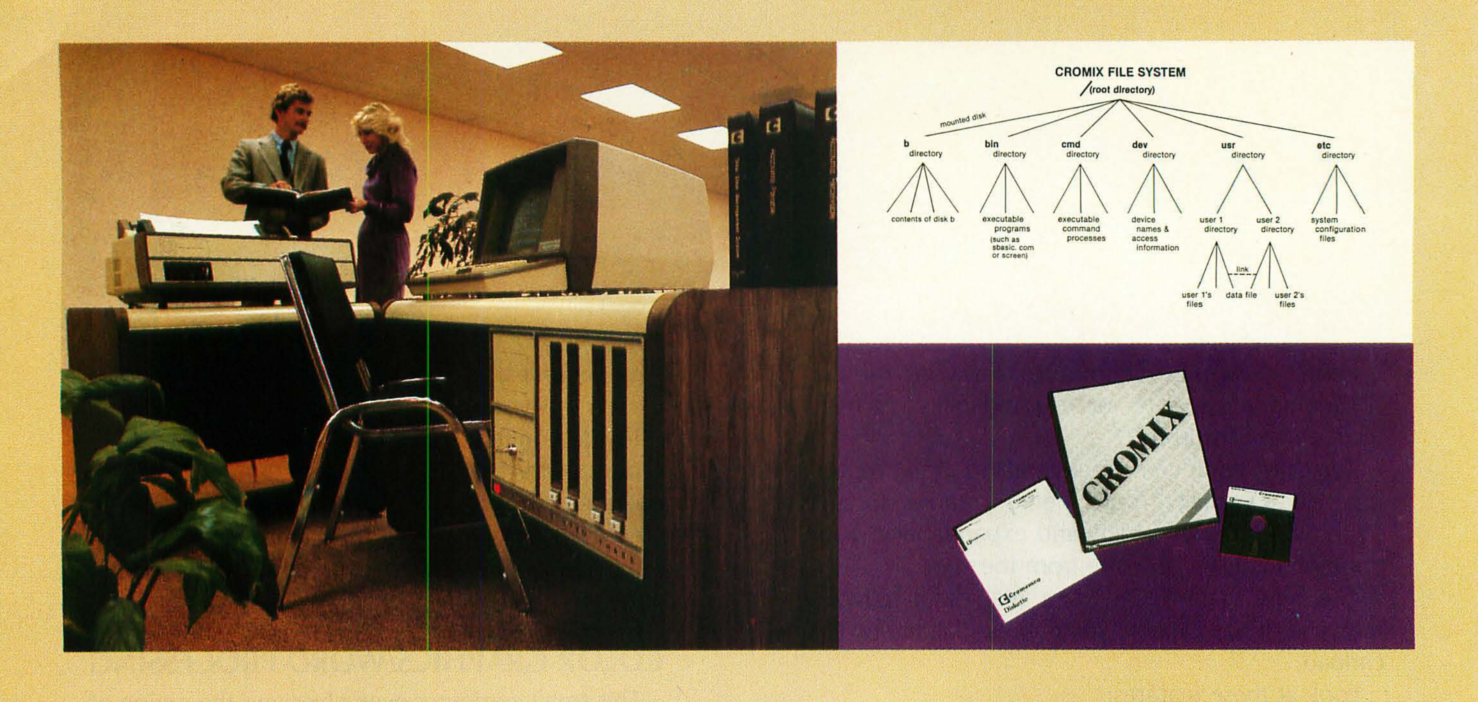
CONTACT YOUR REP NOW

Get all the details on this important building-block computer. Get in touch with your Cromemco rep now. He'll show you how the new System One can grow with your task.

*CROMIX and CDOS are trademarks of Cromemco Inc.
†CP/M is a trademark of Digital Research



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CROMIX*— Cromemco's outstanding UNIX†—like operating system

CROMIX is just the kind of major development you've come to expect from Cromemco. After all, we're already well-known for the most respected software in the microcomputer field.

And now we've come up with the industry's first UNIX-lookalike for microcomputers. It's a tried and proven operating system. It's available on both 5" and 8" diskettes for Cromemco systems with 128K or more of memory.

Here are just some of the features you get in this powerful Cromemco system:

- Multi-user and multi-tasking capability
- Hierarchical directories
- Completely compatible file, device, and interprocess I/O
- Extensive subsystem support

FILE SYSTEM

One of the important features of our CROMIX is its file system comprised of hierarchical directories. It's a tree structure of three types of files: data files, directories, and device files. File, device, and interprocess I/O are compatible among these file types (input and output may be redirected interchangeably from and to any source or destination).

The tree structure allows different directories to be maintained for different users or functions with no chance of conflict.

PROTECTED FILES

Because of the hierarchical structure of the file system, CROMIX maintains separate ownership of every file and directory. All files can thus be protected from access by other users of the system. In fact, each file is protected by **four separate access privileges** in each of the three user categories.

TREMENDOUS ADDRESS SPACE, FAST ACCESS

The flexible file system and generalized disk structure of CROMIX give a disk address space in excess of one gigabyte per volume — file size is limited only by available disk capacity.

Speed of access to disk files has also been optimized. Average access speeds far surpass any yet implemented on microcomputers.

'C' COMPILER AVAILABLE, TOO

Cromemco offers a wide range of languages that operate under CROMIX. These include a high-level command process language and extensive subsystem support such as COBOL, FORTRAN IV, RATFOR, LISP, and 32K and 16K BASICs.

There is even our highly-acclaimed 'C' compiler which allows a programmer fingertip access to CROMIX system calls.

THE STANDARD O-S FOR THE FUTURE

The power and breadth of its features make CROMIX the standard for the next generation of microcomputer operating systems.

And yet it is available for a surprisingly low $595.

The thing to do is to get all this capability working for you now. Get in touch with your Cromemco rep today.

*CROMIX is a trademark of Cromemco, Inc.
†UNIX is a trademark of Bell Telephone Laboratories



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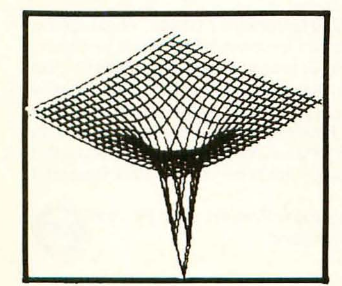
Volume 8, Number 3 March 1982

Features

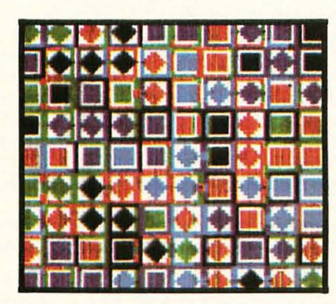
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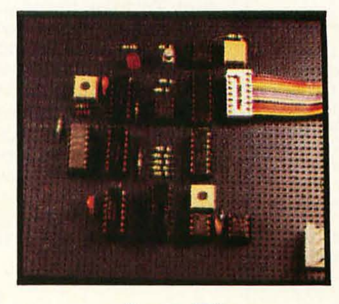
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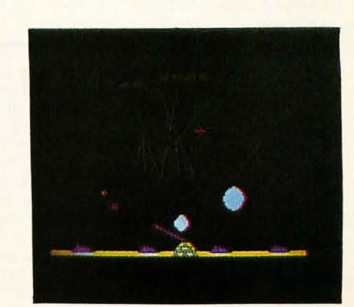
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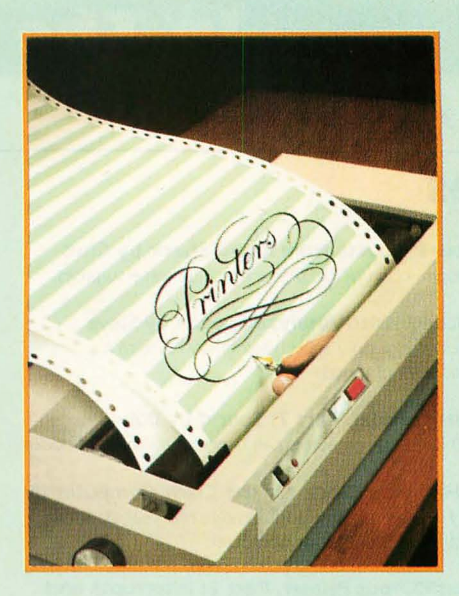
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In This Issue

Hard copy was once considered a luxury by computer hobbyists, but now the ability to record program listings and text on paper is seen as almost a necessity. And though you're not likely to find a printer like the one Robert Tinney pictured on this month's cover, you're sure to find one from the many available that will fit your needs. For a rundown on what's around, see Curtis Feigel's printer directory. For a look at a new approach to printers, see Ed Umlor's review of the Prism Printer. We've also included a report on custom and standardized forms: where to get them and how to use them. And we have an article on programming your computer to fill in forms.

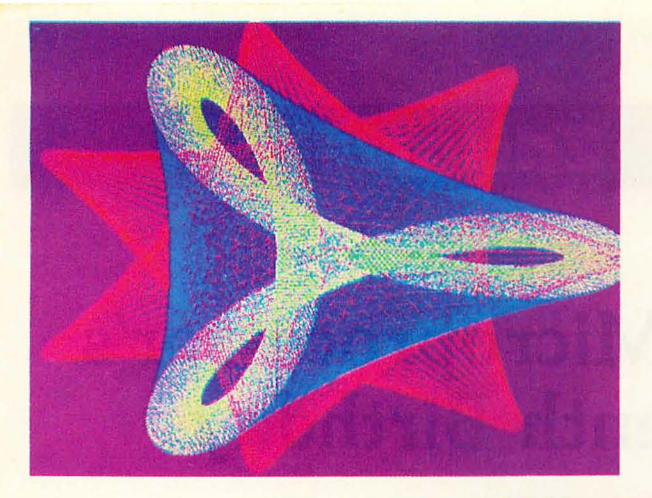
The Atari Tutorial continues with Part 7: Sound; William Barden Jr. discusses building a half-year clock for the Color Computer in the fourth article in his series on Radio Shack computers; in Part 2 of the "Input/Output Primer" Steve Leibson discusses interrupts and direct memory access; and Steve Ciarcia writes about using voiceprints to analyze speech. Don't miss our quarterly games feature, "BYTE's Arcade," plus our regular items and reviews.

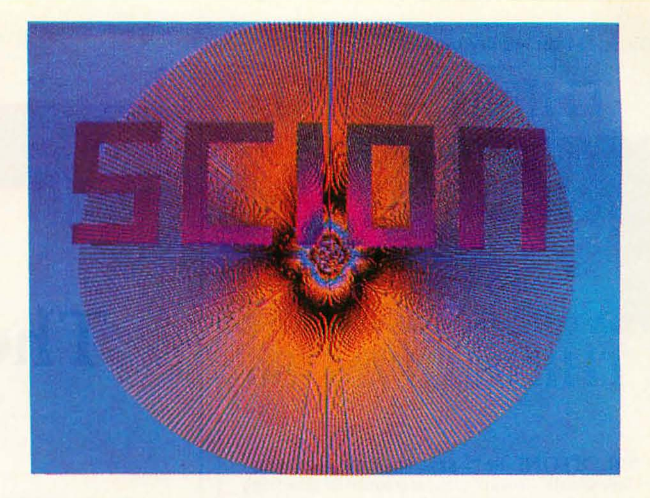
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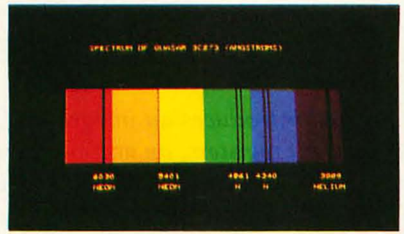


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"...stands well above other S-100 graphics displays in its price and performance range."
BYTE, Product Review



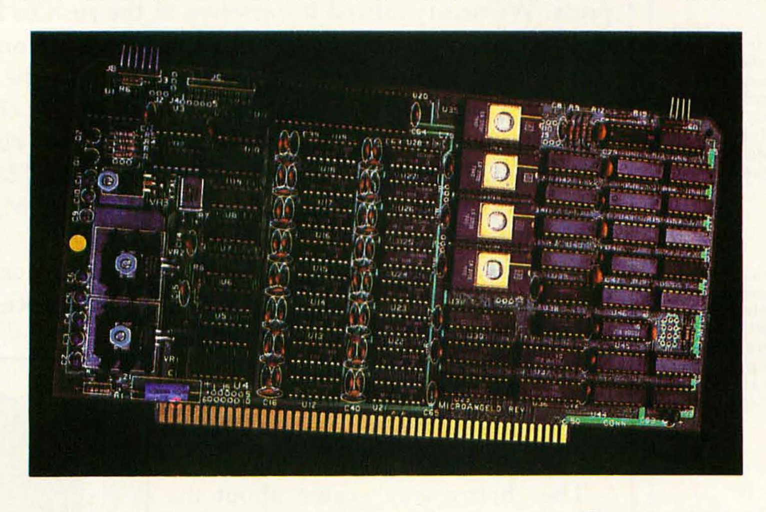
"...better monochromatic ...display...."
ELECTRONIC DESIGN, 1981 Technology Forecast

MICROANGELO

HIGH RESOLUTION GRAPHICS SINGLE BOARD COMPUTER

512 x 480 resolution black and white **and** vivid color displays

- RS-170 composite or direct drive output
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Screenware™ Pak I

A 4K byte operating system resident in PROM on MicroAngelo™. Pak I emulates an 85 character by 40 line graphics terminal and provides over 40 graphics commands. Provisions exist for user defined character sets and directly callable user extensions to Screenware™ Pak I.

Screenware™ Pak II

An optional software superset of Pak I which adds circle generation, polygon flood, programmable split screen for separate graphics and terminal I/O, relative coordinates, faster vector and character plotting, a macro facility, full UCSD Pascal compatibility, and more.

And now...COLOR!!

The new MicroAngelo™ Palette board treats from 2 to 8 MicroAngelos as "bit planes" at a full 512 x 480 resolution. Up to 256 colors may be chosen from 16.8 million through the programmable color lookup table. Overlays, bit plane precedence, fade-in, fade-out, gray levels, blinking bit plane, and a highly visual color editor are standard.

Ask about our multibus and RS-232 versions.



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Editorial

The Microprocessor's Tenth Birthday

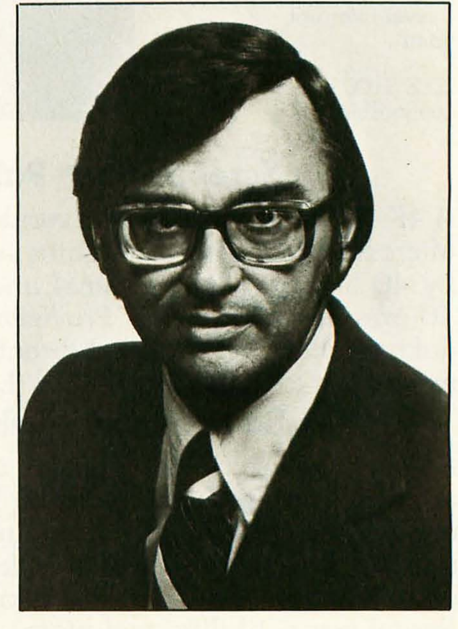
by Chris Morgan, Editor in Chief

". . . Intel introduces an integrated CPU complete with a 4-bit parallel adder, sixteen 4-bit registers, an accumulator, and a push-down stack on one chip. It's one of a family of four new ICs which comprise the MCS-4 microcomputer system—the first system to bring you the power and flexibility of a dedicated general-purpose computer at low cost in as few as two dual in-line packages . . ."

—from the first microprocessor advertisement in the November 15, 1971 issue of *Electronic News*

It's hard to believe, but the microprocessor celebrated its tenth birthday this past November. The event slipped by with little comment from the technical press. We nearly missed it ourselves in the rush to keep up to date in an industry that refuses to slow down and wait for anyone. Nevertheless, it's staggering to realize that ten years have gone by since the calculating powers of the computer were first squeezed onto a small square of silicon. The first microcomputer was actually a family of four integrated circuits known collectively as the "MCS-4 system." It consisted of the 4004 CPU (central processing unit) that featured a set of 45 instructions, the 4001 ROM, the 4002 RAM, and the 4003 shift register.

Ironically, it was a Japanese calculator company called Busicom (now out of business) that spurred the creation of the microprocessor. As Ted Hoff Jr., inventor of the 4004, put it, "The development came as all good ideas do. I looked at a customer's proposed design and said, 'There ought to be a better way.' "


Ted Hoff Jr., inventor of the 4004.

The "better way" came about in 1971 when Busicom contracted the newly formed Intel company to develop a family of integrated circuits that Busicom could use in a proposed line of programmable calculators. The Japanese company had already designed the calculator with about a dozen proposed MOS chips, and it wanted Intel to complete the design. Intel had only two designers at the time, though, and probably would have been hard pressed to design the chips quickly enough if it had not been for Hoff's inspiration. It was all related to Hoff's admiration for the architecture of DEC's PDP-8, a mini-

computer he had been using for some time. "The PDP-8 was a nice machine: simple, yet it could do a lot. I looked at the PDP-8, I looked at the proposed Busicom, and I wondered why the calculator should be so much more complex." Busicom was initially uninterested in the proposed microprocessor. Nevertheless, Hoff's supervisors encouraged him to continue with the design, and Busicom finally relented.

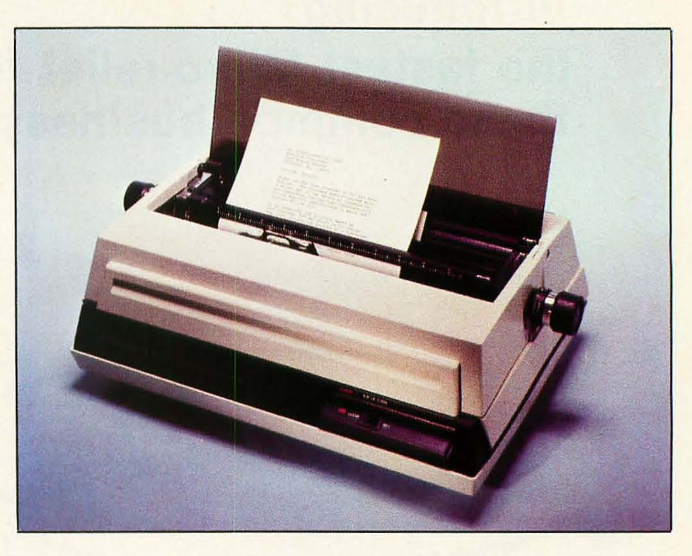
As it turned out, the final configuration of the 4004 in the Busicom calculator was "pretty exotic," as 4004 design team member Stan Mazor describes it. "Shima Masutashi [another member of the 4004 design team who was later to design the 8080] and I worked on the design of the calculator. He wrote a 19-byte interpreter in MCS-4 machine code for the calculator. It performed the relatively trivial task of fetching the next pseudo-byte and jumping to a subroutine. I laughed when I realized that what we had inside the desk calculator was a computer programmed as an interpreter emulating a pseudo-language."

Intel didn't realize at first what it had. An article in a recent issue of Intel's house magazine, *Solutions*, points out that "Intel's own board of directors could not agree on whether to proceed with the sale of the 4004. Their resistance was underscored by the company's marketing department which, based on the belief that microprocessors would only be sold as minicomputer replacements, initially estimated the entire worldwide market at only a few thousand units per year." Today, as we all know, Intel's initial sales estimate was off by several orders of magnitude.

Situations like this are not uncommon in the technical world. A similar situation occurred at the Philadelphia Centennial Exposition of 1876. In a small pavilion at the fair, Alexander Graham Bell exhibited his newly invented telephone to a moderate number of politely interested people. Down the midway, though, thousands lined up to view the real technological hit of the show: the Corliss Steam Engine. I'll refrain from saying which of these two gadgets ultimately became a household item. But I will say that I don't have a princess model Corliss Steam Engine in my den.

Of course the microprocessor ultimately "made it" too, and it continues to affect our lives every day. The personal computer simply would not exist today without the microprocessor. In fact, it created a revolution. In his book *Promise of Power*, Carl Stokes said, "When you start dealing with change you are talking about interfering with those who are in possession of something." This concept doesn't apply to the microprocessor revolution, though, because microprocessors do not deny anything to anyone. Instead, they offer everyone a new tabula rasa. Not even the mainframe computer companies really suffered when the microprocessor appeared: they simply regrouped and continued marching (although it took some of them a long time to do it, and some of them haven't started yet).

Editorial



Smith-Corona's new letter-quality printer, the TP-1.

We congratulate Intel on the tenth anniversary of the fortuitous invention that made personal computing possible, and we look forward to the day in 1992 when we can examine the second decade of the microprocessor.

* * * * * *

An $895 Daisy-Wheel Printer

This month's theme is printers, and the most exciting news in the fast-changing printer market is undoubtedly Smith-Corona's new $895 (suggested retail) letter-quality printer, the TP-1. It features a plastic daisy wheel plus either an RS-232C serial interface or a Centronics-style parallel interface. Maximum speed of the TP-1 is between 14 and 15 characters per second, but the average speed is closer to 12 characters per second.

Smith-Corona makes no apologies for the fact that the TP-1 is a bare-bones system, and even though it lacks such niceties as proportional spacing, double-striking capability, and bidirectional printing, it's still a bargain. Price-wise, its closest competitor is in the $1500 range. The American-made unit accepts letter or legal-sized paper, and, in a new version, will soon be able to handle fanfold paper. The TP-1 has some competition in the form of add-on boards that convert the Olivetti Praxis typewriter into a letter-quality printer. They're manufactured by Vertical Data Systems Inc., Mississauga, Ontario, Canada (Converter TP35); Williams Laboratories, Ithaca, New York (Bytewriter); and Systemed Corporation, Mountain City, Tennessee (Typrinter). We plan to review these units as soon as possible, for they herald the beginning of a new age of affordable word-processing computer systems. ■

Acknowledgments

Thanks to Donna Shuster and Intel for permission to reprint quotes and comments from the article "Tenth Anniversary of the Microprocessor" in the November/December 1981 issue of Solutions.

S-100 Fast-Aid.

Including 3 new boards for system design relief.

The MB64.

An economical, high-performance 64K static RAM memory.

Just what the doctor ordered. A new 64K static RAM configured as two 32K blocks that's fast (in excess of 6MHz), reliable and economical. The MB64 supports IEEE 696/S-100 24-bit extended addressing for up to 16MB of RAM. Bank switching permits compatibility with popular multi-user computer systems (such as CROMIX*). Up to 8K can be replaced with 2716 EPROMs. The MB64 offers low power consumption (typically less than 600 milliamps). And a provision for optional battery backup.

(The MB64 is priced at less than $850.)

*CROMIX is a trademark of Cromemco, Inc.

The IO8.

An I/O board featuring eight serial interfaces, individually programmable baud rates, and an interrupt clock.

Give your system fast-aid—including easier testing and speedier diagnosis—with SSM's new IO8. This board features eight asynchronous serial RS-232 I/O ports with LED data transfer indicators. Individually programmable I/O port baud rates (110-19,200) meet all your specific configuration requirements. A timer (50/60 Hz) supports real-time or multi-user applications.

And all our Fast-Aid boards offer:

- Card ejectors for painless card removal.
- LEDs for easy troubleshooting and monitoring.
- IEEE 696/S-100 compatibility.

The IO5.

A two-serial/three-parallel I/O board with programmable timer.

The perfect remedy for fast system integration, more precise diagnosis, and far healthier system operation. The IO5 features two RS-232 asynchronous serial interfaces for maximum peripheral compatibility. The board supports a variety of devices with high-speed serial data transmission (110-19,200 baud). Three parallel ports, providing a total of 32 bits, support various I/O configurations: a 16-bit software programmable bi-directional interface, and two 8-bit interfaces. One 8-bit interface supports direct connection to Centronics-compatible printers. The other provides 8 bits of parallel input for such devices as keyboards. The IO5 also offers a software-programmable timer for real-time or multi-user applications.

For more details about these new boards, or any of SSM's S-100 compatible boards (including various CPU, EPROM, video and development boards), just call your local dealer or SSM today.

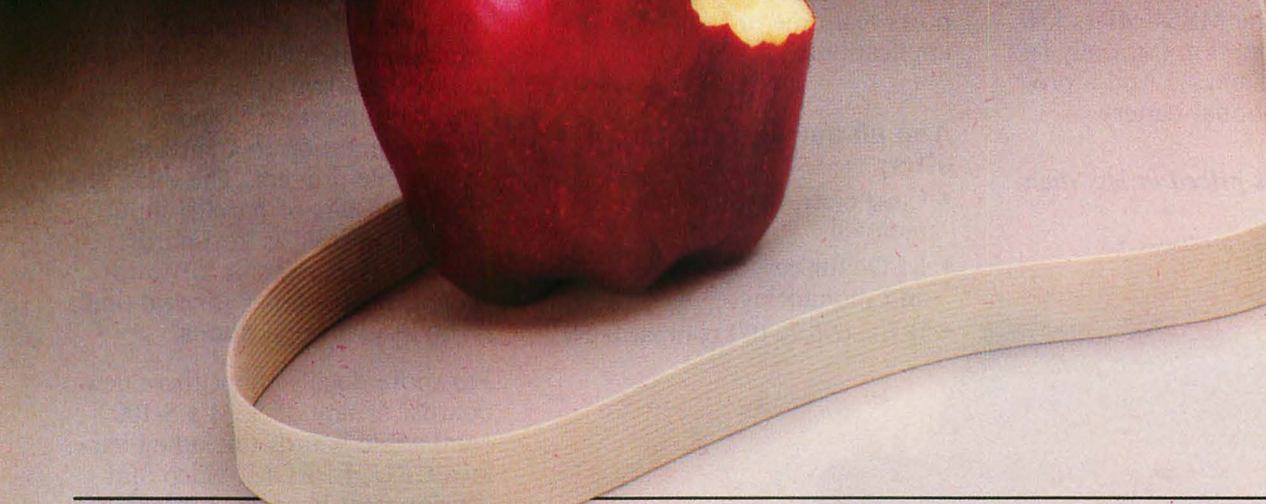


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The disk drive that puts more byte into your Apple.



Introducing the first totally compatible Floppy Disk Drive.

Rana Systems has designed a totally compatible disk drive for Apple, that's better than Apple's. A high density, high capacity disk drive and controller that offers a myriad of features Apple never thought of. Unique advantages that get the maximum efficiency out of your existing Apple II® hardware and software.

At Rana, we knew you wanted more storage, so we went right to the core of the problem. Even our most economical model is designed to give you 15% more storage capacity than Apple's. Our top-of-the-line unit gives you 4 times the capacity of Apple's comparable unit. Even our design is far more dramatic than theirs. With lines that actually complement the sleek Apple II computer.

We're a step ahead of Apple because we have a faster step.

Holding more information is even more valuable when you can get it faster. The Rana System track positioning mechanism is engineered to access three to four times faster track to track, with greater accuracy than Apple's. Our disk drive offers safeguards like a stall provision to protect spin motor burnout,

Apple II is a registered trademark of Apple Computer Inc.

an advanced write protect feature that keeps your information where you put it, and an energy saving device that "powers down" when your disk drive is taking a break.

We even took a bite out of Apple's price.

Our most popular model is 25% more economical per byte than Apple's, providing you with maximum performance, superior cost efficiency, and totally compatible styling. It also comes with a free diskette containing all the optional software and supports you'll need to enhance the capacity and performance. And it's all backed up with an efficient service support system, and a full 90 day warranty.

The Rana System Floppy Disk Drive. Just plug it into your Apple and all those delicious extra bytes will be yours.

RanaSystems™



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In California only call: 1-800-262-1221. Source Number TCT-654.
See our booth at the West Coast Computer Faire Show.

Apple's Decision Questioned

We use Apple computers for commercial machine-language program development and buy Apple IIs at frequent intervals, either as a service to our customers or in order to expand our office.

I have recently spoken to a mail-order distributor of Apples who told me that as of December 4, 1981, Apple was no longer wholesaling to mail-order houses. I could not believe this, so I called CALL-A.P.P.L.E. It's true, I was told.

I am outraged. How can Apple, with new, large, clever, powerful competitors just beginning to breathe down its neck, remove the only way for small, intelligent users to buy Apples inexpensively?

Apple is, in effect, forcing us to buy from retail stores, which are usually overpriced. Their personnel are insulting in their inexperience and knowledgeable only about the latest space games. We can not afford their arbitrary $700 markup on the Apple II. Our software systems, while cost-effective with mail-order firms' prices, are not with the retail stores' prices.

Apple will have to decide just who its friends are—the retailer who sits on his duff selling other people's ideas or the software innovator who takes a piece of hardware and makes it usable by the masses. While Apple may be trying to help out its dealers, it seems to have decided to do this at the expense of its serious customers—the people on whose success its own utlimate success depends.

Apple has succeeded so far because it provides a product which we (and others) can program without too much trouble and which our customers can afford. This new attitude of demanding that we submit to retailers' ridiculous prices will compel many to reconsider which personal computer we will use to develop our systems. I hope Apple discovers its error before its competitors profit too much from it.

Dennis Gerald Pratt
666 North Dearborn, Apt 3F
Chicago, IL 60610

Yes, it is true. Apple Computer Inc. has given its dealers an ultimatum: either cease all mail and phone order sales, or your authorized dealership will be terminated effective December 4, 1981. This was delivered in a "Notice of Dealer Agreement Modification" dated November 2, 1981, and dealers had until November 20, 1981, to sign and return the "modification." Otherwise, Apple threatened to pull the plug, so to speak.

Apple is attempting to justify this move by stating: "We believe that our ability to maintain a leadership position in competition with the corporate giants now entering the personal computer field depends in large measure on the willingness of our dealers to satisfy the end user with their familiarity with Apple products and their commitment to passing on this knowledge and support." Accordingly, Apple has added subparagraph 3 (g)(iv) to its Authorized Dealer Sales Agreement: "Dealer and Apple recognize that because of the special, technical nature of Apple Products, customers purchasing them can be properly served only if they have the benefit of pre- and post-sale education, orientation and support, specifically including in-person contact with the selling dealer, in order that each customer's needs may be properly served and the features, benefits, operation and applications of the Apple Products being purchased may be demonstrated and fully explained by knowledgeable sales personnel." It then goes on to specifically prohibit mail and telephone order sales of Apple products under penalty of losing the dealership.

Apple concluded its modification notice with the following paragraph:

"Apple personal computer products demand innovative and creative marketing. We are willing to work with all who are willing to meet that challenge. Those who are unwilling to expend the effort have no place in our future plans." . . . **MH**

Is Microfiche the Answer?

This letter is in response to the letter of Lew Merrick (October 1981 BYTE, page 10) regarding the storage bulk of advertising material in BYTE back issues.

The separation of advertising material into a separate removable section is undesirable because it would reduce the exposure of the advertising, reduce the value of the advertising, and ultimately degrade the quality of BYTE by reducing revenues.

An alternative is to convert to microfiche files at some loss of convenience but great savings in space. BYTE is now available from University Microfilms, Ann Arbor, Michigan, but you must be very patient with them because (1) back issues are available only in one-year blocks, (2) back issues are not produced until well into the following year, and (3) orders are not filled promptly.

My suggestion is that BYTE offer a microfiche subscription option, just as is now done with the IEEE journals. The microfiche might actually be cheaper to produce and ship than the paper edition.

A microfiche viewer can be used for many purposes and occupies about as much space as three years of BYTE. The space needed to store the fiche is negligible.

Back issues of BYTE are well worth preserving, as they enable me, after a session on my modest micro, to ponder what little was available only five years ago and to speculate what the future holds. The advertisements in a five-year-old BYTE issue contain some very interesting material.

Richard Schwartz
Electrical Engineer
Star Fleet Engineering
1328 North Santa Anita Ave
Arcadia, CA 91006

More on the WAI

Regarding Dr. S. S. Reddi's "Where Am I?" instruction (Technical Forum, November 1981 BYTE, page 413), I would like to point out that Motorola's 6809 has such an instruction. The simplest form is:

```
TFR     PC,X
```

The instruction transfers the value in PC (program counter) to register X. (The value transferred is the location of the next instruction.) The 6809 also allows:

```
LEAX     n,PC
```

which adds "n" (8 or 16 bits) to PC and puts the result in register X. (LEA = Load Effective Address) This instruction, which may also be written:

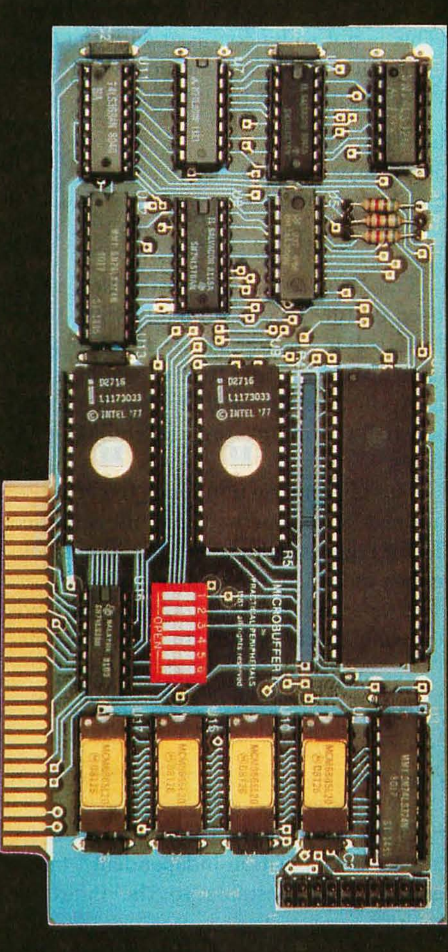
```
LEAX     label,PCR
```

can compute the address of any label (location) within the program without using an absolute address (PCR means use

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PC-relative addressing). In these examples, the destination register could be Y, U, or S, instead of X, if desired. The destination for the TFR instruction could also be register D, which is accumulators A and B treated as one 16-bit register.

I question the usefulness of a WAI (Where Am I) instruction by itself, however. Apparently, Dr. Reddi would like to get the value of the 6502's program counter and then use this value to set up a table of addresses in page zero of memory, to be used with page zero indirect addressing (or, I shudder, to modify addresses within his program, such as jump and subroutine addresses). Adding a WAI instruction to the 6502 would help, slightly, with this rather clumsy method of making programs relocatable.

Much more is needed to make programs easily relocatable. The ideal situation would be to have code that runs at any address with no changes required. This is called position-independent code. The 6809 has the necessary instructions for such code. In addition to the LEAX (and LEAY, etc.) mentioned above, its instruction set includes branches (jumps), both conditional and unconditional, and subroutine calls with relative addressing. The relative address can be either 8 or 16 bits long, the latter allowing relative addressing anywhere within the 6809's address space. (Subroutine calls and unconditional jumps are also available with absolute addressing.) The presence of these instructions allows writing programs that can be run at any address with no changes (and with no need to set up a table of addresses or to modify the code at run time).

The WAI instruction by itself solves only a small part of the problem of being able to have position-independent code, code that will run unchanged at any address. Perhaps this is one reason it is not present in most computers. Most (or all) computers that have a WAI instruction, such as the 6809, PDP-11, 68000, and IBM 370, are also capable of position-independent code. I suspect that the 8086, Z-8000, and VAX 11/780 are also in this category.

Another reason for the absence of WAI in most microcomputers is that most 8-bit microprocessors were intended for use in dedicated controllers where there is no need for position independence or a WAI instruction.

One may note that the 6800 has a WAI instruction, namely:

```
        BSR     NEXT
NEXT    EQU     $
```

This use of BSR (branch to subroutine), which uses relative addressing, pushes the address of the next instruction onto the stack, where it can be easily retrieved. (This is not to be confused with the 6800 instruction whose mnemonic is WAI. This WAI means "wait for interrupt.")

Jim Howell
5472 Playa Del Rey
San Jose, CA 95123

The "Where Am I?" instruction is indeed useful. That is probably why it was included in the design of the Motorola 6809 as the Load Effective Address, or LEA, instruction, and its use is not restricted to finding the current PC contents.

The LEA instruction loads the effective address of its operand into the specified 16-bit register, which may be either stack, either index, or the double accumulator. The operand must use the indexed addressing mode, which includes PC-relative. "Where am I?" could be coded:

```
HERE  LEAX  HERE,PCR
```

Assuming that you want HERE to be in the X register.

Other uses for the LEA instruction are addressing position-independent tables and adding constants to the indexable registers.

I recently read an article comparing the 6502 and the 6809 in which the author complained that he wasn't able to find much use for the LEA instruction. This caused some amusement among my friends. A close examination of some of my own code reveals that the LEA instruction is one of the most heavily used. I would venture the opinion that position-independent code would be much more difficult to write without it.

Howard Lee Harkness
Word's Worth
POB 28954
Dallas, TX 75228

Architecture Controversy

It was nice to see your article on higher-level machine-language constructs, "Should the DO Loop Become an Assembly-Language Construct?" by Glenn L. Williams (October 1981 BYTE, page 413). I would like to add a couple of comments to Mr. Williams's remarks.

Since Mr. Williams was including minicomputers in his article (he references the PDP-11 and VAX 11/780) he might also have included a reference to the HP3000 instructions MTBA, MTBX, TBA, and TBX. These four instructions each perform a variation of Mr. Williams's NXT function. All the instructions use a loop variable, a limit value, and a step value. TBA and MTBA use a variable address on the stack while TBX and MTBX use the index register for the loop variable. In all cases, the limit and step values are on the stack. MTBA and MTBX modify the variable by the step value, which may be any integer, positive or negative, and compare the result to the limit value. Positive step values cause a check to see if the limit has been exceeded, and negative step values cause the check to see if the result is less than the limit. TBA and TBX do not modify the variable but check only for the limit being exceeded. These allow compilers to implement more complex counting-loop structures than can be accomplished by adding or subtracting a step size. Also, functions similar to Mr. Williams's SRCH function are performed by SCU (SCan Until memory byte matches test byte or terminal byte) and SCW (SCan While memory byte matches test byte or until terminal byte is found) on character strings.

With the growing acceptance of modular, structured programming it has long been my feeling that high-level constructs should be imposed at the machine-instruction level. The only real need for assembly language these days is to utilize the machine architecture not available at the high-level-language level to produce quick, short code. Implementing high-level functions in machine language and providing optimizing compilers should just about eliminate any need for assembly language. Code produced would be very short and quick, because a single complex machine instruction should run faster than the many simpler instructions put together needed to accomplish the same function. I would like to see both micro- and minicomputer processors developed with instructions to implement WHILE, IF . . . THEN . . . ELSE, CASE, DO . . . UNTIL, and other high-level constructs at the machine-instruction level.

Let's all keep pushing for advances in architecture to keep up with advances in software. And thanks, BYTE, for being among the leaders in this respect.

David B. Mears
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Santa Clara, CA 95051



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Glenn Williams is undoubtedly correct when he says that the instruction sets of microprocessors can be improved. For various reasons, however, I do not agree with his specific proposals.

It will always be necessary to write programs in assembly language, but if the "software crisis" can be solved at all it will only be by the efficient implementation of high-level languages. Processor designers have clearly realized this, but unfortunately their attempts at providing "features" that are supposed to help the compiler writer are often misguided. Consider, for example, two of the features mentioned by Mr. Williams: stack and condition registers.

There are two principal reasons for using stacks in the implementation of a high-level language. One is to save and restore environments when procedures are called, and the other is to provide fast temporary storage during expression evaluation. Typical PUSH and POP instructions do not help in either case: to save and restore an environment we need an appropriate addressing mechanism, and expressions can be evaluated faster using registers than stacks in memory.

If we were interested only in simple test-and-jump coding, condition registers would be fine, but in high-level language programming this is not always the case. The Pascal statements

```
finished := eof OR (lines > maximum)
```

and

```
total := total + width * length
```

have the same structure. On a processor with condition registers, however, the first is coded by means of an elaborate sequence of jumps, while the second is a simple sequence of arithmetic operations. There is no reason why tests should not leave their results in ordinary registers, like other instructions.

The DO statement that Mr. Williams proposes would not be used by any but the most sophisticated optimizing compiler. First, it is inappropriate for loops in which a termination test is made on entry to, rather than on exit from, the loop body. This is not required for FORTRAN, but it is for Pascal. Second, the DO stack must be adjusted if an exit occurs before the loop is completed, and that is often, whatever the structured-programming zealots say. Third, a special addressing mode is required so that the code within the loop can access the DO index, because the DO index lives in the DO stack.

The real requirements have been accurately summarized by Professor William Wulf ("Compilers and Computer Architecture," *Computer*, July 1981): the compiler writer wants well-designed primitive instructions, not solutions to problems. A small set of efficient, useful instructions is better than a vast number of "clever" instructions that do the right thing in special circumstances but require elaborate analysis in the general case.

Peter Grogono
Metonomy Productions
4125 Beaconsfield Ave.
Montreal, Quebec
H4A 2H4 Canada

SR51A vs. HP-41C Calculations Continued

I thank Mr. Kitchen (Letters, October 1981 BYTE, page 20) for another opportunity to discuss accuracy in Hewlett-Packard calculators. I fear he missed the point; please note my earlier statement regarding predicability (Letters, April 1981 BYTE, page 16). Then try this with an SR51A or a similar calculator:

1. Take the square root of 2. On both your SR51A calculator and my HP-41C, the display shows 1.414213562. Square this result. You get 2; I get 1.999999999. Subtract 2. Neither machine yields zero, but yours looks like it will, unless you "chisel out" the hidden digits first.
2. Enter 1.414213562 through the keyboard, then square it. If your display reads 2, feel free to be outraged: your machine does funny arithmetic. Indeed, the SR51A does not yield 2 as a result, but, considering what happened in (1), it looks like it will. How much work are you willing to do to discover how your calculator is going to behave? If it is really a 13-digit machine, why must you trick it to reap the benefits?

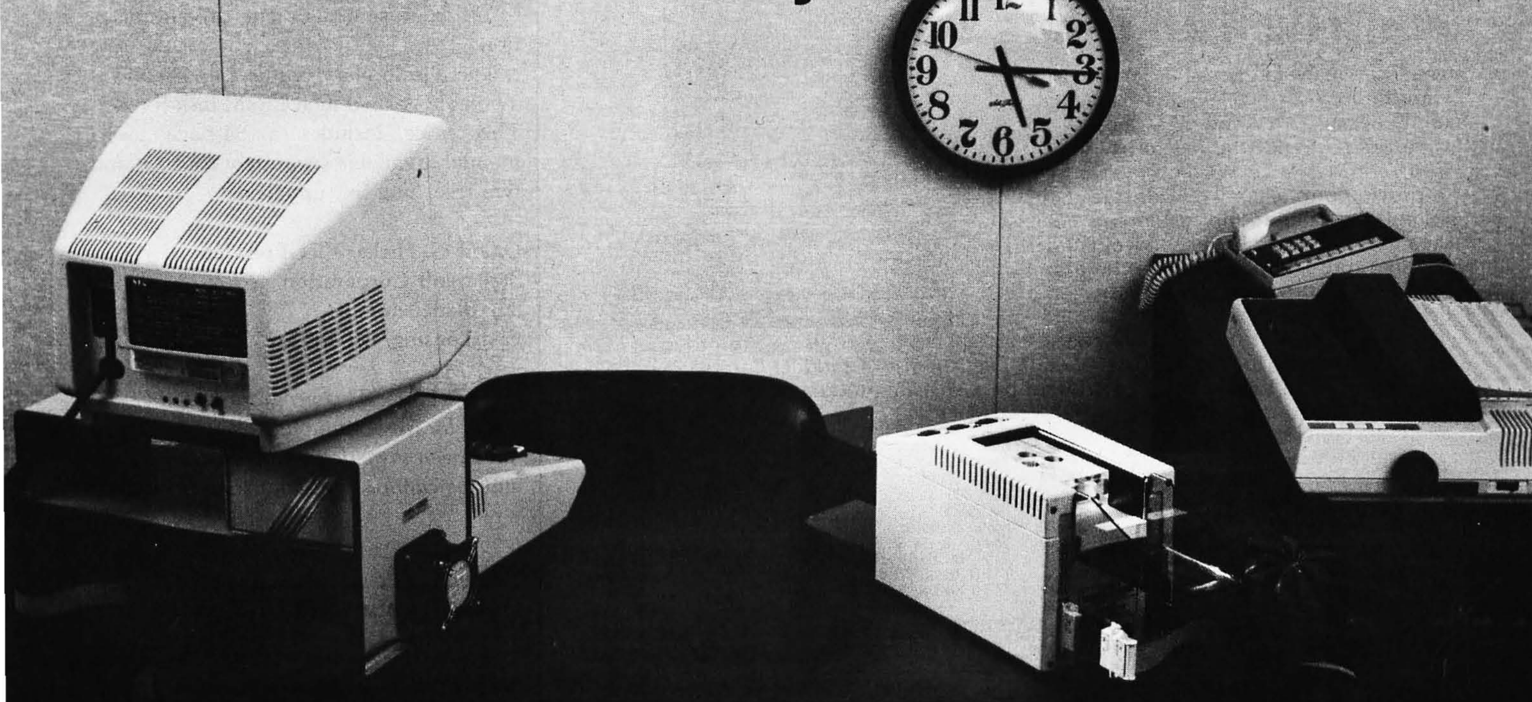
I could go on. At great length. And not just about SR51s and square roots.

In some cases, the SR51A yields better results than an HP-41C. *But which cases?* In chain calculations, digits 11, 12, and 13 can become numerical noise that creeps into the visible mantissa, causing mysterious results whose origins are very hard to isolate.

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digits is one reason. When unavoidable numerical errors occur, they are predictable, repeatable, and immediately apparent. *Serious numerical analysis demands this;* braggadocio does not.

Once again: a calculator is a tool, an extension of the mind. It must be *understandable* and *understood* by the user. Consider what can happen if this is not the case for a variety of tools you may use (e.g., power saws, guns, automobiles). Then consider who uses calculators seriously: scientists, engineers, bankers, and doctors.

The designers at Hewlett-Packard keep such things firmly in mind.

Steve Abell
Research & Development Engineer
Hewlett-Packard Company
Corvallis Division
1000 NE Circle Blvd.
Corvallis, OR 97330

The Big Spelling Sweepstakes

The spelling-correction software review by Phil Lemmons ("Five Spelling-Correction Programs for CP/M-Based Systems," November 1981 BYTE, page 434) gives me new faith in the free-enterprise economic system of business. He has correctly pointed to the best value in a computer dictionary program: The Word from Oasis Systems.

When this program was released I compared it to the "high-priced spreads" and came to the conclusion that a big-budget ad campaign would always get results for the less-valued product. The way that various magazine editors and writers were talking up certain overpriced spellers I thought that the big dollars would win over the underfinanced little organizations. I concluded I was wrong after reading your comprehensive review.

I'm sure there's a lot of egg on many a face this day—and rightly so. There are always some individuals willing to lend their names to products they don't fully understand. Furthermore, they let their names to used without understanding the competitive positions they are taking. That seems to be a characteristic of our culture—if action is required, act even if you don't have the facts.

The time is rapidly approaching when the fast-buck artist can no longer get away with his "get-rich-quick" schemes, thanks in no small part to magazines like yours.

Frank Joseph
10925 Stonebrook Dr.
Los Altos Hills, CA 94022

We wish to inform BYTE and its readers that there is a sixth spelling-correction program on the market that, according to Mr. Lemmons's benchmarks, outperforms the others. This program is called the Disc-tionary.

We ran the Disc-tionary on Mr. Lemmons's 400-word benchmark text and it found all seven misspellings, yet failed to recognize only eight additional correctly spelled words. The total time to proofread and mark the file was only 47 seconds on a typical computer when the word review feature was skipped (1:12 with word review). A 3100-word file can be proofread in 1:12 without review. While it is impossible to make direct timing comparisons due to the use of two different computers, the Disc-tionary obviously combines a high level of accuracy with a large vocabulary. This gives the user a higher level of safety and convenience than the other programs.

We believe that the Disc-tionary presently provides the best combination of speed and accuracy. It is also very easy to use because of its menu-driven operation.

The Disc-tionary requires a Z80 and is available on an 8-inch CP/M disk for $79. This price includes a 54-page user's manual (available separately for $15) and two free "bug fix" updates.

David G. Hicks, Vice-President
Stellarsoft Corporation
841 Blanchette Dr.
East Lansing, MI 48823

Editor's Note: *This program has not been tested by Mr. Lemmons. The times above have been provided by the manufacturer, and we cannot vouch for their accuracy.*

An Avalanche of Answers

I have received some pretty strange and fascinating responses to a question I put to Steve Ciarcia that was printed in "Ask BYTE" (July 1981 BYTE, page 218).

Apparently, Steve didn't provide what the readers thought was the best answer and they quickly let us both know. The

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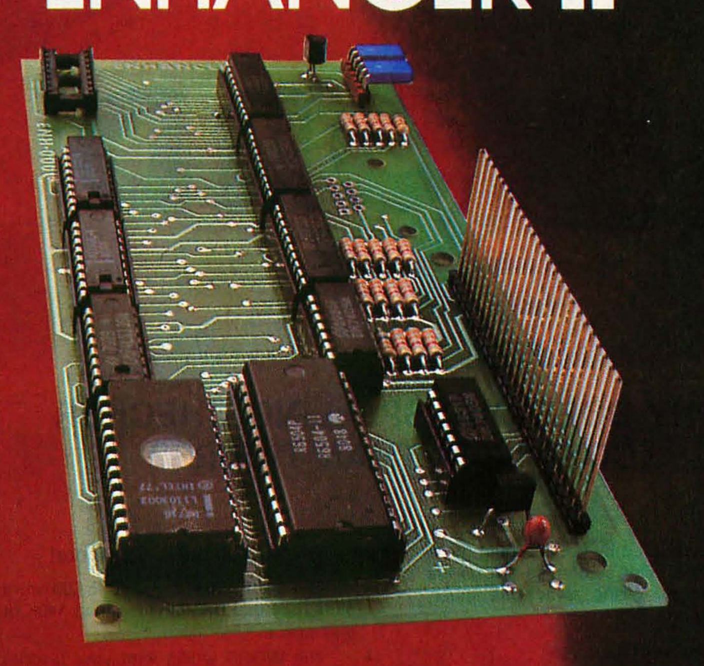
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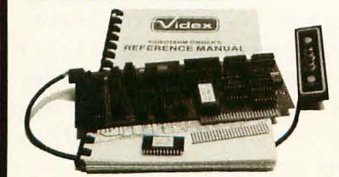
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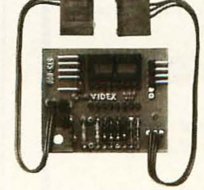


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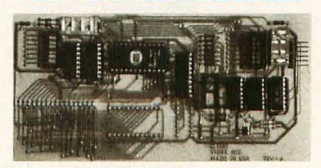
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day I got my magazine I also got a long-distance call asking if I was Dave Bower and if I owned a TRS-80 and if I had written to BYTE magazine. The caller then answered my question. The next day I got a letter answering the question. There's nothing strange about getting a letter, except that you didn't print my address, and neither did the person sending the letter! And it continued like that for the next couple of months—letters and phone calls from all over the United States. And just when I thought it was over I got a package from Steve Ciarcia containing the letters he had received!

So, needless to say, I got my question answered. And I got a lot more too. I think every person that contacted me also shared more hints and/or information or whatever. So even though they all called or wrote me about the same thing, not one exchange was a waste of time.

I just wanted to let you know what kind of readers you have and that I think Steve has a pretty good column, and a well-read one too.

Dave Bower
741 Lake Edward Dr., Apt. 104
Virginia Beach, VA 23462

Closing the Net

Harry Saal's article on local networks ("Local-Area Networks, Possibilities for Personal Computers," October 1981 BYTE, page 92) did injustice to your readers with its narrow scope and omissions. Specifically:

1. Datapoint's local coaxial network-based ARC system was introduced and installed in 1977.
2. About 2000 ARCs are installed and in commerical service worldwide—more than all other networks, prototype or otherwise, combined. (I have heard no argument to estimates that Datapoint has a 95 percent market share of installed local networks.)
3. Tandy uses the local network portion of ARC, ARCNET, for its TRS-80 Model II personal computer network, announced in September—a step of major significance.
4. Three companies now use ARCNET—Datapoint, Inforex, and Tandy.
5. The only deliverable chip-based local network interface is manufactured by Datapoint.

Considering these omissions, I'm skeptical that the article was well researched.

Gerard Cullen
Vice-President Marketing
International Operations
Datapoint Corporation
9725 Datapoint Dr.
San Antonio, TX 78284

Harry J. Saal replies:

My article was not intended as a complete survey of local-area network products. Datapoint's offerings in the high-speed, serial, coax network were indeed quite early; it is unfortunate that Datapoint has not provided any in-depth technical information in the published literature by which its system can be evaluated for comparative study. In September 1981, several months after my article was completed, Datapoint announced its relationship with Tandy, a very exciting recent development.

Let me assure Mr. Cullen that there are substantially more than 100 installed, non-ARC local networks worldwide; hence the 95 percent market share claim is false. ■

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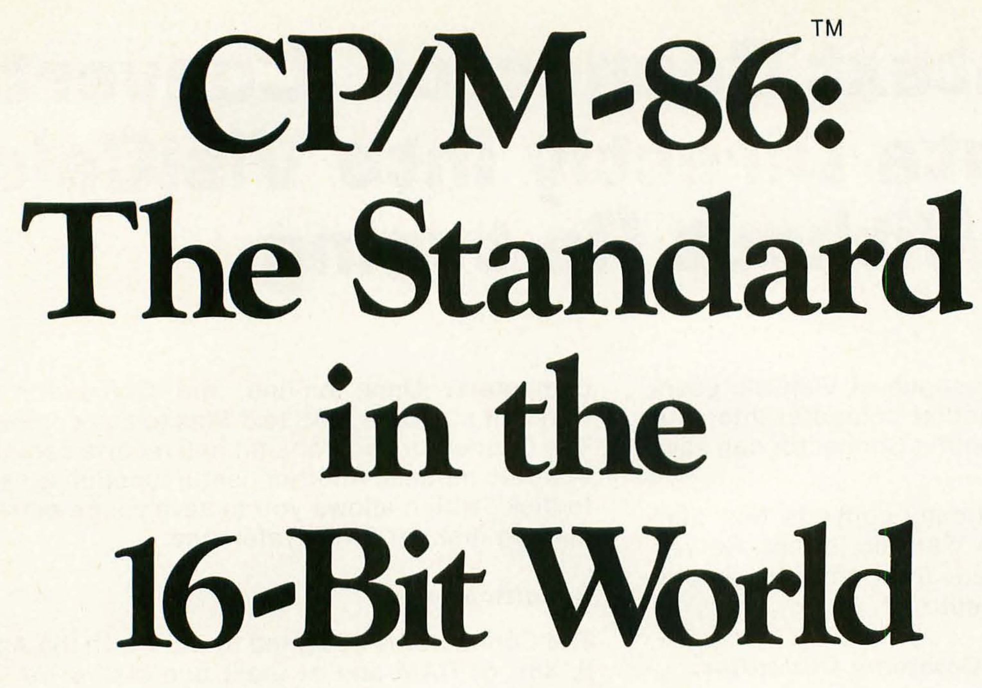
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INSTALLED BASE (MILLIONS OF SYSTEMS)

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TOTAL BUSINESS PROFESSIONAL OTHER

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Source: Insite Onsite October 1981

DIGITAL RESEARCH™

Hardware Review

Commodore 4022 Printer

Joseph Holmes
13049 Broadway Terrace
Oakland, CA 94611

Some marriages are made in heaven—others are made in Japan. Commodore Business Machines has joined Epson to produce a fine, low-cost printer that combines the hardware features of the Epson MX-80 with the upgraded operating system of the Commodore CBM 2022 printer. Latest in a series of new products from Commodore, the CBM 4022 will handle most printing jobs where the 8½- by 11-inch paper size and dot-matrix output are acceptable.

The 4022 is totally compatible with all Commodore 2000, 4000, and 8000 series computers. The printer requires no special interface other than a cable. The 4022 prints the entire CBM/PET character set (256 characters), which means that listings and graphics programs come out just as they were entered (see figure 1). It is controlled by an internal microprocessor, which gives the 4022 versatile line-spacing and formatting capabilities. You can design your own business forms; you can even design and print special characters. The 4022 has both a replaceable line cord and an external, easily replaceable fuse.

In order to detail the other features of the CBM 4022, I will compare it to its cousin, the MX-80, and to its father, the CBM 2022.

At a Glance

Name
Commodore Business Machines Dot-Matrix Printer Model CBM 4022

Use
General (listings, reports, business forms, graphics, draft-quality word processing, etc.

Manufacturer
Commodore Business Machines and Epson
3330 Scott Blvd.
Santa Clara, CA 95051

Dimensions
10.7 by 37.3 by 33 cm (4¼ by 14¾ by 13 inches); the weight is 6.6 kg (14.6 pounds)

Price
$795

Additional Hardware Needed
Cable (CBM to IEEE-488 or IEEE-488 to IEEE-488)

Features
Disposable heavy-duty 8-wire jeweled print head, cartridge ribbon, 80-column width capability, 5 by 8 dot-matrix characters (6 by 8 for graphics), true lowercase descenders, maximum print speed of 80 lines/minute for 20 columns (40 lines/minute for 40 columns), programmable line spacing, user-designed characters, paging with variable lines/page, enhanced (widened) characters, two character sets, and built-in error messages

Documentation
Commodore **User's Manual**, 45-page paperback (supplied with printer); Osborne/McGraw-Hill **PET/CBM Personal Computer Guide**, 2nd edition, 501-page paperback (supplied with computer)

Audience
Programmers, businesspeople, engineers, educators, students, writers, hobbyists, or others with Commodore 2000, 4000, or 8000 series microcomputers.

CBM 4022 Versus Epson MX-80

Many of the 4022's features overlap those of the MX-80. Both have a self-diagnostic print test and lowercase descenders (one-dot descenders with the 4022 and two-dot descenders with the MX-80). Line spacing defaults to 1/6 inch (six lines per inch) in the 4022 and to either 1/8, 1/6, or 7/72

****

CBM 4022 PRINT SAMPLE

****

PET KEYBOARD: STANDARD CHARACTER SET (UNSHIFTED)

@!"#$%'&\()←[]QWERTYUIOP↑<>ASDFGHJKL:ZXCVBNM,;?789/456*123+0.-=

PET KEYBOARD: STANDARD CHARACTER SET (SHIFTED)

PET KEYBOARD: ALTERNATE CHARACTER SET (UNSHIFTED)

@!"#$%'&()|qwertyuiop<>asdfghjkl:zxcvbnm,;?789/456*123+0.-=

PET KEYBOARD: ALTERNATE CHARACTER SET (SHIFTED)

[]QWERTYUIOP↑ ASDFGHJKL ZXCVBNM

REVERSE FIELD: ABC 123

ENHANCED: ONCE—TWICE—3 TIMES

USER DESIGNED CHARACTER:

Figure 1: *Print sample of the Commodore CBM 4022 printer showing the entire character set, reversed and enhanced print, and user-defined characters.*

inch in the MX-80. The line spacing can be altered (under software control) from between 1/216 and 127/216 (0.0046 to 0.5880) inch increments on the 4022 and between 1/72 and 85/72 (0.0139 to 1.180) inch increments on the MX-80.

Characters printed by the 4022 can be enhanced (widened). This can be done several times, if desired. Print enhancement with the MX-80 means emphasized print and/or double striking; both processes make the characters closer to correspondence quality. The 4022 is a tractor-feed printer that accepts paper in 4- to 10-inch widths. The print head is disposable, has a useful life of from 50 to 100 million characters, and costs less than $30. (Another disposable print head, which is longer lasting and 3 decibels quieter, sells for around $40.) The ribbon is housed in an easily changed cartridge, which needs replacing after about 3 million characters, that sells for around $14. Otherwise, the basic internal hardware of the two machines is virtually identical.

In printers, as in marriage, compromises often must be made. In order to accommodate the versatile CBM operating system, the 4022 has missed some of the juicier features of the MX-80:

- The MX-80 prints 10 characters per inch (cpi) at 46, 73, and 105 lines per minute for 80, 40, and 20 columns, respectively. The corresponding print speeds for 10 cpi with the 4022 are 30, 50, and 80 lines per minute.
- The MX-80 has its own set of 64 block-graphic characters. (I believe, however, that these graphics are far less interesting than the Commodore graphics.)
- The MX-80 has 12 printing modes that combine four character-width sizes: *normal*, 10 cpi; *normal double width*, 5 cpi; *compressed*, 16.5 cpi; and *compressed double width*, 8.25 cpi with four print densities: *standard*, *emphasized*, *double strike*, and *emphasized plus double strike*. Epson's MX-80 prints all these combinations of print sizes and print densities—except *enhanced* and *enhanced plus double strike* for the two *compressed* sizes.
- The four type sizes used by the MX-80 give a range of 40 to 132 characters per 8-inch line. The CBM

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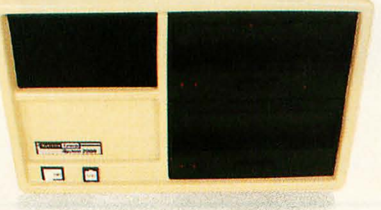
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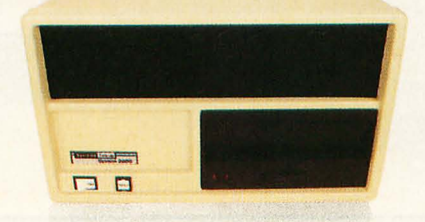
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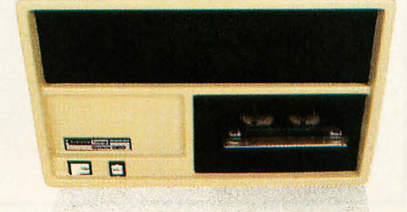
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4022 has one print mode and one type size giving 10 cpi or 80 characters per 8-inch line. Characters can be widened, however, for special effects.

- The character matrix of the MX-80 is 9 by 9 dots, whereas that of the CBM 4022 is 6 by 8 dots (5 by 8 for nongraphic characters). This allows two-dot lowercase descenders for the MX-80 versus one-dot descenders for the CBM 4022.
- The MX-80 has four indicator lights: Power On, Printer Ready, Paper Out, and On Line. The four switches on the MX-80 are Power On/Off, On Line, Form Feed, and Line Feed. In addition, a warning buzzer responds to paper-out and error conditions. The CBM 4022 has one indicator light (Power On), which also flashes for paper out, and two switches: an On/Off switch and a Paper Advance button that takes you to top-of-form or feeds continuously if held down.
- The MX-80 lists for $645; the CBM 4022 lists for $795. Since no additional interface board is needed to connect to PET/CBM computers, you could come out ahead with the 4022.

CBM 4022 Versus CBM 2022

How does the CBM 4022 stack up against its predecessor, the CBM 2022? Physically, they are quite different. The 4022 is lighter and far more compact. It is also much quieter—a plus for the families of nighttime programmers! The 4022 has true lowercase descenders; the 2022 does not.

Both printers share a slightly annoying bug. When in the lowercase mode, the *backslash*, the *left arrow* and *up arrow*, and the *left* and *right brackets* must be shifted to achieve their normally unshifted appearance. For their shifted versions, or graphics, you must type them unshifted. I have learned to live with this. The earlier model's paper advance couldn't find the top-of-form, but it was useful for advancing the paper short distances without turning the knob. The new model makes it more difficult to back up the paper without crinkling precious hard copy.

Both CBM printers have formatting and other features that are controlled by a system of *secondary addresses (sa)*. These features are activated by opening *files* (channels) to one or more of the secondary addresses and then printing to the appropriate file. The earlier model 2022 had these seven secondary addresses:

sa 0: Print exactly as received
sa 1: Print according to an established format
sa 2: Establish format field
sa 3: Set number of lines per page
sa 4: Activate error messages
sa 5: Design custom character
sa 6: Set spacing between lines

The later model 2022 added an eighth secondary address (*sa 7*) that switched the entire PET/CBM character set from uppercase/shifted

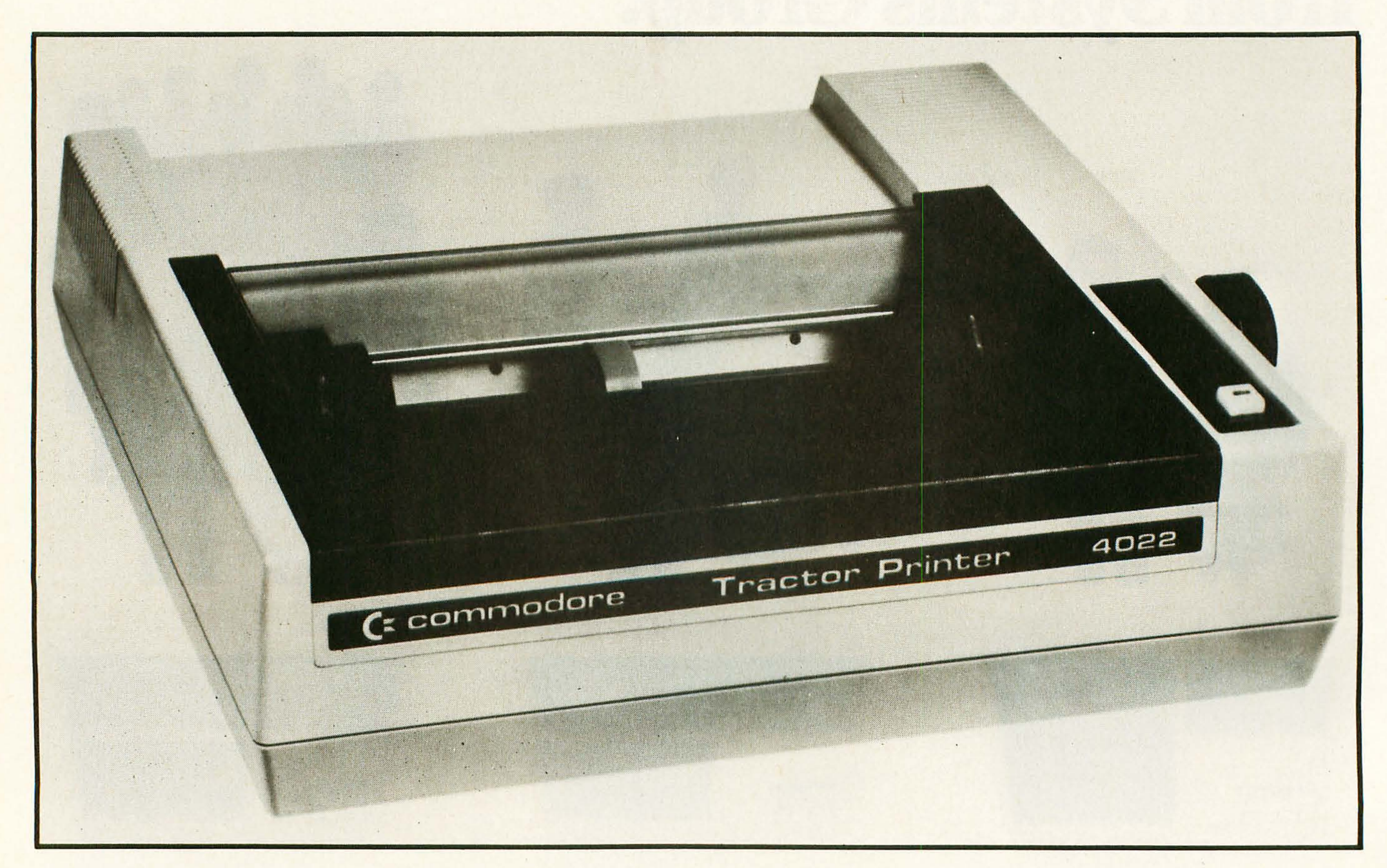


Photo 1: *Manufactured in Japan by Epson, the new CBM 4022 combines the hardware features of the MX-80 with the upgraded operating system of the CBM 2022 printer.*

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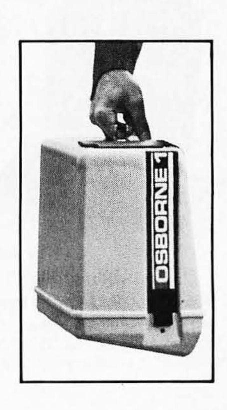
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graphics to lowercase/shifted uppercase. However, this upgrade had one nasty bug. Often, when another secondary address was accessed, the character set would switch inexplicably to lowercase. The only remedy for this was to reset the printer by turning it off and then on again. The CBM 4022 has overcome this problem with the addition of three more secondary addresses: numbers 8, 9, and 10—for a total of 11. Secondary address 8 switches the printer back to uppercase mode. Secondary address 9 closes the channel to *sa 4*, the error channel, and *sa 10* resets the printer so that only *sa 0* (the default channel) is left open. These new addresses allow much better and more reliable direct keyboard and software control of printer functions. The last four secondary addresses for the CBM 4022 are:

sa 7: Switch to lowercase
sa 8: Reset to uppercase
sa 9: Turn off error channel
sa 10: Reset everything

Let's look at some of the 4022's features in more detail. If a file (channel) has been opened to *sa 1*, all printing will be in a format that was previously established. This format was set up by opening file *sa 2* and then assigning a format field (or image string) to a string variable, then printing that string variable to the file open to *sa 2*. The format field that governs output layout is similar to the image fields used in the PRINT USING command found in some versions of BASIC.

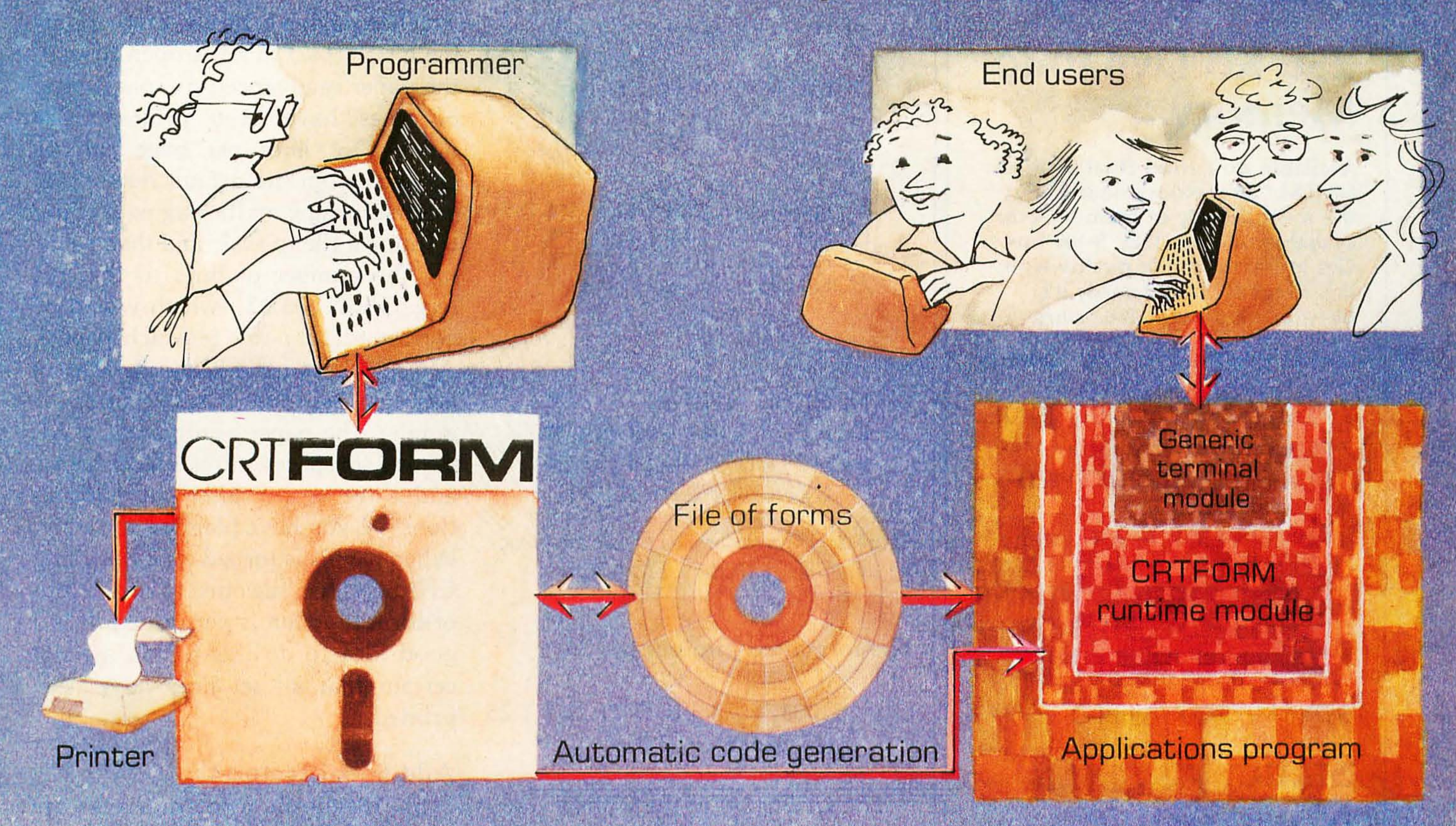
Here are a sample PRINT statement, a format field, and the formatted printout. (The values of the variables used are A$ = "OK", A = 37, B = 86, C = 8.27, D = 1.28, E = 1.25, F = 26.51, G = −3, H = −3.) The PRINT statement is:

```
PRINT#1,"A$CHR$(29)CHR$(160)
  CHR$(29),A,B,C,D,E,F,G,H"
```

The format field for this PRINT statement is:

```
AAAA  AAA ZZZZ R| 9999R|
99.99 ZZ.99 $99.99 $$$.99 S99 99−
```

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```
LOOSER   +++|||
LINE     +++|||
SPACING  +++|||
3 LINES PER INCH
```

can be embedded in the format field. These embedded literals are useful in creating special forms as a part of the printout.

When paging is turned on by printing CHR$(147) to a file open to *sa 0*, the paper is advanced six spaces after 60 lines have been printed. The number of lines per page can be changed from the default number 66 by first turning on the paging feature

Function	CHR$ Value	Keystrokes
Enhance On	CHR$(1)	none
Enhance Off	CHR$(129)	none
Paging On	CHR$(147)	CLR/HOME (shifted)
Paging Off (Reset)	CHR$(19)	CLR/HOME
Reverse Field On	CHR$(18)	OFF/RVS
Reverse Field Off	CHR$(146)	OFF/RVS (shifted)
Carriage Return	CHR$(13)	RETURN
Carriage Return (no feed)	CHR$(141)	none
Line Feed	CHR$(10)	none
Uppercase	CHR$(145)	CURSOR UP *
Lowercase	CHR$(17)	CURSOR DOWN *
Skip Space	CHR$(29)	CURSOR RIGHT
Insert Leading Blanks	CHR$(160)	SPACE (shifted)
Quote	CHR$(34)	Quote (") **

* These functions are reversed if *sa 7* is in effect.
** This can be a forced quote within a PRINT statement. Also, an odd number of quotes allows control characters to be printed in their graphics form.

Table 1: *Control characters sent through secondary addresses 0 and 1.*

per inch (see figure 2). To do so, you must choose a divisor for 216 that will give a quotient that is the number of lines per inch that you want (default = 36 for 6 lines per inch): 18 yields 12 lines per inch and is nice for graphics that normally get too stretched out vertically when printed; 24 yields 9 lines per inch, but some graphics with this spacing are still too stretched out. If you want normally spaced text and somewhat compressed graphics, you can leave an extra space between text lines in your program and then change your spacing to 12 lines per inch. The *User's Manual* needs a revision on line spacing. The values given on page 31 are incorrect; they are left over from the model 2022. To correct them, change the 144 to 216, and change the divisors accordingly. You can use any divisor from 1 to 127. Dividing 216 by 1 will, of course, give a quotient of 216—the number of lines per inch (1/216, or 0.0046, inch spacing). Dividing 216 by 127 will give a quotient of 216/127, or approximately 1.7 lines per inch (127/216, or 0.5880, inch spacing).

The CBM 4022 and 2022 both have a set of special control characters. Their functions and equivalent keystrokes are listed in table 1.

To get more information on the use of these controls plus the other features of the CBM 4022, consult either the Commodore *User's Manual* or the appropriate sections of the *Personal Computer Guide*, 2nd edition, published by Osborne/McGraw-Hill.

Conclusions

The CBM 4022, manufactured by Epson for Commodore, is the dot-matrix printer of choice for users of PET/CBM computers because of the Commodore specificity of its operating system. It compares well with its cousin, the Epson MX-80.

This printer is an improvement over the earlier CBM 2022 because it has true lowercase descenders; is quieter; has an inexpensive, disposable print head; uses a cartridge ribbon; and has overcome some serious bugs with the addition of three new control channels (secondary addresses).

The CBM 4022 features control characters, secondary address channels, the full CBM 256-character set with graphics, and user-designed characters. Although the CBM 4022 still has a minor bug or two, its weakest point is the inaccurate user's manual.

The $795 list price is reasonable, considering that a simple cable is the only extra expense.

I have used both the CBM 2022 and the new CBM 4022 printers during the last year. Although most of my time has been spent with the earlier model, I am very pleased with the upgraded version as it has worked well for me. I enthusiastically endorse the Commodore CBM 4022 printer. ■

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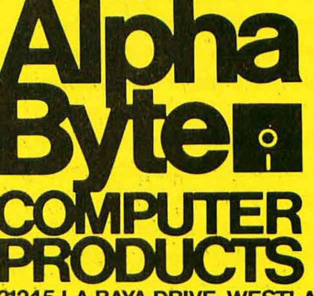
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Four New Products from Radio Shack

by Chris Morgan

It was Christmas all over again on January 19 at Radio Shack in Fort Worth, Texas, where a quartet of major new products was unveiled during a day-long session. Some of the announcements were expected. Others were surprises.

The TRS-80 Model 16: Two Computers in One

The most significant announcement was for the new TRS-80 Model 16 computer, which contains a Motorola M68000 processor (see photo 1). Externally, the unit looks like the TRS-80 Model II (in fact, the case is virtually identical to the Model II's), but the front bezel has been redesigned to accommodate either one or two slim-line 8-inch drives. Two of these drives fit into the same amount of space as a single, standard-width drive. The big surprise is that Model II owners will be able to convert their machines to Model 16s by adding two printed-circuit boards that together cost $1499. But there's one limitation: the maximum RAM (random-access read/write memory) on the upgraded Model II system is 256K bytes, whereas the Model 16 allows the user up to 512K bytes of RAM on board.



Photo 1: Radio Shack enters the 16-bit market with the Model 16. While cosmetically very similar to the Model II, the Model 16 contains a Motorola 68000 processor and can address up to 512K bytes of memory. Two slim-line 8-inch floppy-disk drives can be installed in the same space occupied by one standard-width drive. When used in conjunction with Radio Shack's 8-megabyte Winchester hard-disk drive, one drive is sufficient. The Model 16 also contains a Z80 processor. Though normally used for disk I/O, the Z80 is employed in a Model II emulation mode and addresses its own 64K-byte memory. Upon booting up, the Model 16 automatically enters the 16-bit mode. A few simple commands place the machine in Model II emulation mode.

The Model 16's most important feature is its built-in Z80 coprocessor with 64K bytes of its own memory that allows the user to run all existing Model II software. Radio Shack's simple but clever idea is to free up the 68000 processor by using the Z80 for disk and I/O routines. This has to be one of the most elegant answers to the question of 8- and 16-bit compatibility. The operating system (Radio Shack's own design) boots up like the Model II, but automatically enters the 16-bit mode. A simple keyboard message from the user switches the system to the Z80 mode.

Floppy Disks and Hard Disks

The slim-line floppy-disk drives are double sided and double density, with slightly more than one megabyte capacity each (formatted). Normally, a user would get only one floppy-disk drive for operating the Model 16 with a Radio Shack 8-megabyte hard-disk unit. Such a configuration (with the maximum 512K bytes of RAM) costs $11,191—a bargain. By comparison, the least-expensive configuration, featuring 128K bytes of RAM and one disk drive (no hard disk), Costs $4999. This certainly gives the IBM Personal Computer some competition. (It should be kept in mind that the Model 16 lacks some of the IBM's features, such as color graphics.)

The announcement of the TRS-80 Model 16 gives the 68000 processor a firm footing in the 16-bit sweepstakes. (Can Apple be far behind with its 68000 design?) It's safe to say that the 16-bit era is underway.

An Updated Pocket Computer

The PC-2 Pocket Computer is an improved version of the current TRS-80 Pocket Computer, now known as the PC-1. Like the PC-1, the PC-2, shown in photo 2, is manufactured for Radio Shack by Sharp, in Japan, and features a built-in real-time quartz clock; a 7-by-156 dot-matrix liquid-crystal display; an 8-bit processor operating at 1.3 MHz; a new extended BASIC package with two-dimensional arrays, built-in arithmetic functions, and variable-length character strings; a four-color printer-plotter/dual-cassette interface (more about this later); and a 60-pin I/O con-



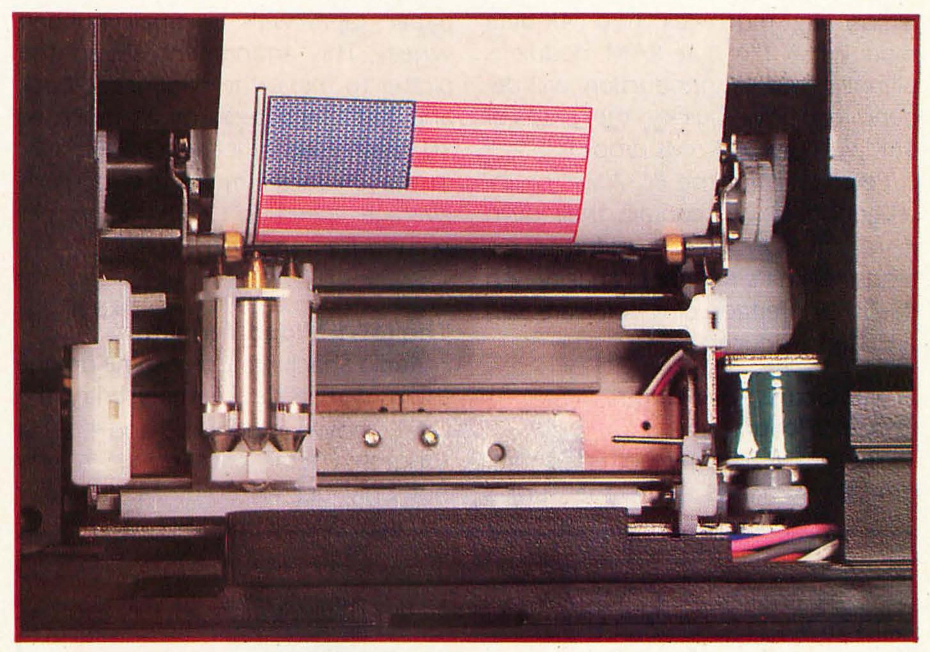


Photo 2: The PC-2 Pocket Computer from Radio Shack features an optional four-color PC-2 Printer/Plotter. The PC-2 contains 2.6K bytes of RAM and 16K bytes of ROM. Provision for a plug-in module allows an additional 16K bytes of RAM, ROM, or both. A 4K-byte RAM module is available for $69.95. PC-2 peripherals are intelligent and contain additional RAM and ROM. The Printer/Plotter can produce nine sizes of characters and plot graphs and charts with a resolution of 0.2 millimeter.



Photo 3: Though cosmetically similar to the Model III, the DT-1 video terminal uses the same monitor section as the Model II. Communication is through an RS-232C port, and both serial and parallel printer ports are provided. Transmission rates of from 75 to 19,200 bps are supported, all through keyboard commands.



Photo 4: The DT-1 video terminal achieves new heights in configurable systems. Not only does the DT-1 have built-in provisions for emulating four popular terminals, it can also be programmed from the keyboard to emulate most other terminals with similar capabilities. Emulation and transmission parameters are stored in an EEPROM, which means, in effect, that the DT-1 programs itself. Parameters can be changed on a more temporary basis as well, without being programmed into the EEPROM.

nector that brings address data, interrupts, timing, and control signals to the outside world.

The basic PC-2, which retails for $279.95, contains 16K bytes of ROM (read-only memory) and 2.6K bytes of RAM. There is provision for one additional plug-in module which may be RAM, ROM, or a combination of both. A 4K-byte RAM module is available for $69.95, and an 8K-byte RAM will be introduced in the near future. The 8K-byte RAM is expected to cost almost as much as two 4K-byte modules. A 16K-byte RAM module is planned, but its introduction will depend on how quickly the price of 16K-byte CMOS RAMs drops.

Peripherals for the PC-2 will be intelligent and will contain their own RAM and ROM which will further extend the unit's memory capacity. An RS-232C interface plus software will also be introduced.

A Miniature Four-Color Printer/Plotter

The PC-2 Printer/Plotter is impressive. Packed into the unit's minuscule chassis is a four-color plotter that "draws" letter-quality characters in nine different sizes on standard 2½-inch adding-machine tape and creates four-color graphs and charts (see figures 1 and 2). A small circular barrel holds the four miniature solenoid-selectable pens.

The PC-2 Printer/Plotter is not a toy; it is capable of plotting with a resolution of 0.2 millimeter! It features a simple, yet sophisticated paper-drive system that anchors one side of the paper tape with a small nubbed wheel. This arrangment allows the plotter to move the paper tape back and forth repeatedly by as much as 10 centimeters as it creates an image. In the character mode, the printer's average speed is 12 characters per second (see photo 2).

The DT-1 Video Terminal

Radio Shack has done some unique things with its new terminal entry, the DT-1, shown in photos 3 and 4. For a suggested retail price of $699, you not only get an 80-by-24 character display, serial-communication port, and both serial- and parallel-printer ports—you also get the built-in capability of emulating a number of other terminals, including the Televideo 910, Lear Siegler ADM-5, ADDS 25, and Hazeltine 1410. This is accomplished by simple commands from the keyboard; no DIP switches to set. All emulation parameters as well as transmission protocols such as word length and data rate are then stored in an EEPROM (electrically erasable programmable read-only memory). Thus, the DT-1 actually reprograms itself. Even when power is turned off, the DT-1 retains its emulation and transmission parameters.

As if that weren't enough, you have the ability to change any or all of the emulation and transmission parameters, which allows you to emulate a number of other terminals in addition to those that are built in. The cursor is programmable from the keyboard and may be either a steady or blinking block or underline. The video attributes include normal, reverse, invisible, blink, underline, and half intensity. Data rates from 75 to 19,200 bps are available. The black-and-white monitor section of the DT-1 is identical to that of the Model II computer.

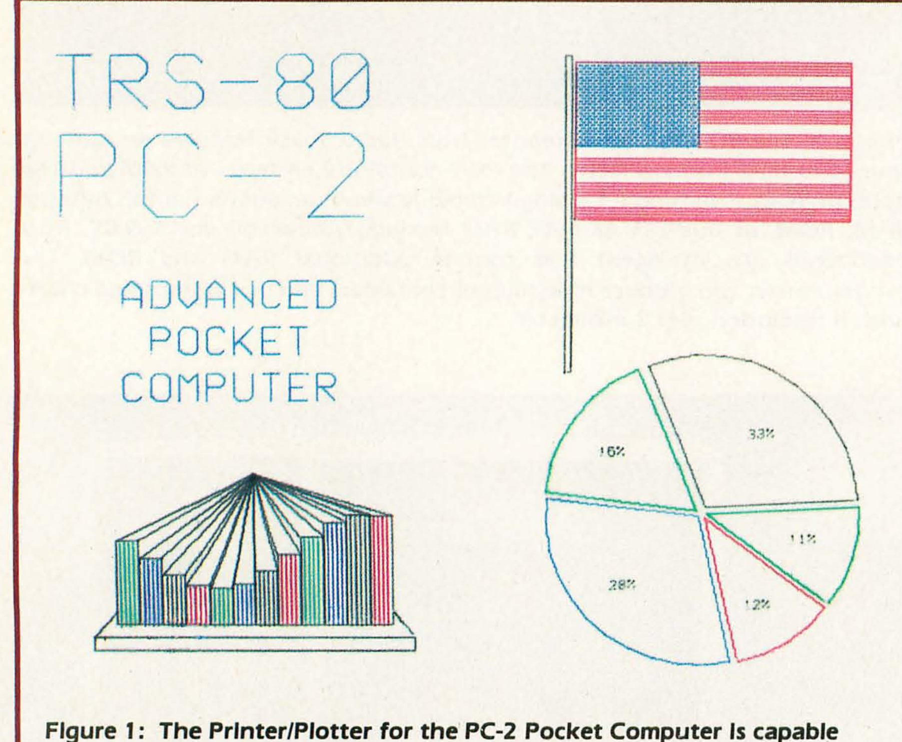


Figure 1: The Printer/Plotter for the PC-2 Pocket Computer is capable of 0.2 millimeter resolution in four colors. Characters may be presented in nine different sizes. Charts and graphs are no problem for this machine.

High-Resolution BASIC Graphics Package for the Model II

A $499 high-resolution BASIC graphics package that allows the user to create black-and-white graphics with a resolution of 640 by 240 pixels is now available for the TRS-80 Model II (see photos 5 and 6). The price includes a plug-in printed-circuit board with 32K bytes of on-board memory. Because the high-resolution graphics are generated from a separate memory, both text and graphics can be overlaid on the screen and each can be cleared separately.

The accompanying BASIC package features the same commands as the high-resolution BASIC for the TRS-80 Color Computer, except that only black and white can be chosen. Radio

Shack is including a library of commands that allow you to pass parameters from COBOL, FORTRAN, or assembly-language programs—a nice touch.

Yet to come is a printer dump routine that lets the user dump the screen to the Radio Shack Lineprinter VIII. Note: In order to use the high-resolution BASIC graphics package, your Model II must have the latest CPU (central processor unit) board, because the original Model II CPU board has a different set of wait states than the graphics board requires. Radio Shack will retrofit any Model II with the latest CPU board if you bring your computer to a Radio Shack computer center. The upgrade, if needed, is included in the cost of installing the graphics package.

Final Thoughts

These four new products from Radio Shack indicate both a continuing commitment from the company to the furthering of the state of the art, and reaffirmation of the company's refreshing entrepreneurial approach to new computer products. ■

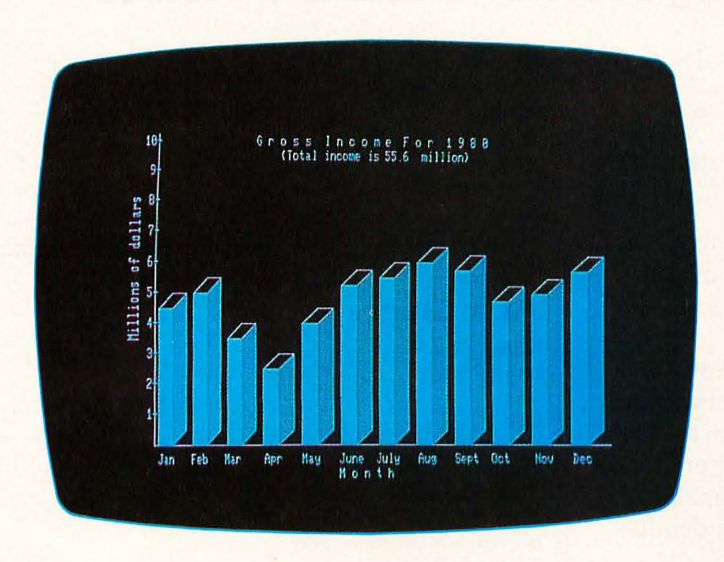


Photo 5: A bar graph produced with the Model II high-resolution graphics package. Both text and graphics can be mixed on the screen and selectively erased.

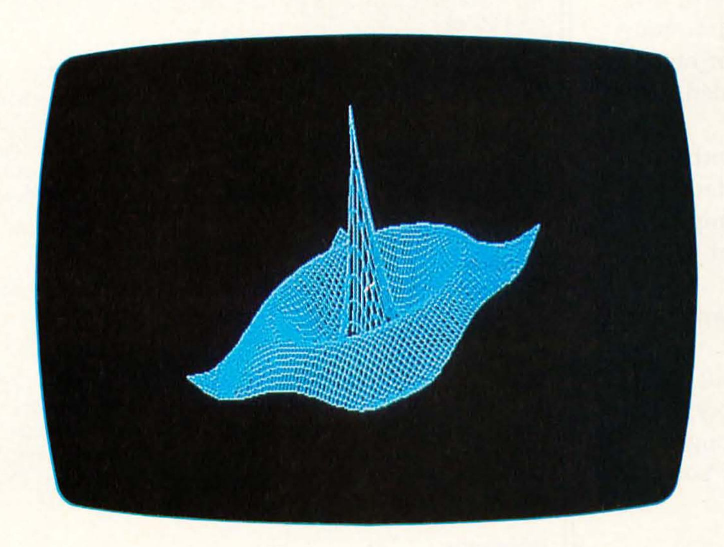
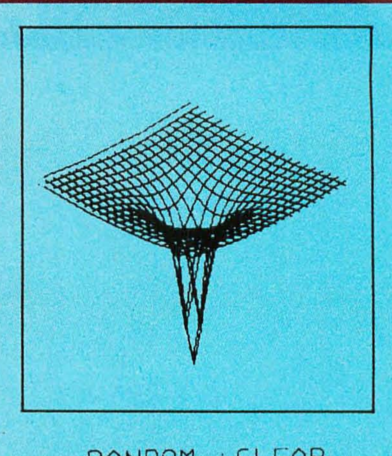


Photo 6: Another example of what is possible using the Model II high-resolution graphics package.



```
    RANDOM :CLEAR
    :DIM A$(1)*56:
    DEGREE .WAIT 0
10:K=0:RESTORE 50
    .FOR I1=1TO 10
    :READ A$(1).
    PRINT A$(1)
15.FOR J=1TO 60:A
    $=INKEY$ :IF A
    $<>""LET J=60
20.NEXT J
22.IF A$=""THEN 3
    5
25:FOR J=1TO 10:
    IF MID$ ("1234
    ABCDEF", J, 1)=A
    $LET K=J. J=12
30:NEXT J
31.IF KCLS :ON K
    GOSUB 100, 2000
    , 600, 800, 300, 4
    00, 500, 700, 900
    , 1000. GOTO 5
35:NEXT I1.IF RND
    (25)>2THEN 10
40:K=RND (10).IF
    K<>8THEN 31
45:GOTO 10
50:DATA "1 - LCD
    display & grap
    hics", "2 - Fea
    tures Banner",
    "3 - Clock", "4
    - Beeper"
55.DATA "A - 3-D
    Bar Chart", "B
    - Pie Chart", "
    C - 2-D User B
```

Figure 2: Mixing text and graphics is easy with Radio Shack's new Printer/Plotter. Also shown is a partial BASIC listing.

Integral Data Systems' Prism Printer

Ed Umlor
E & G Umlor Enterprises
4 South Street
Milford, NH 03055

Integral Data Systems (IDS) has introduced an innovative printer called the Prism, whose modular design uses add-on options which let you upgrade the machine as needed.

The basic 80-column Prism is available for $899 and yields correspondence-quality print using an overlapping 24 by 9 dot matrix. Printing bidirectionally at 110 characters per second (cps) (up to 150 cps for proportionally spaced characters) the Prism printer is capable of 10, 12, or 16.8 character-per-inch densities, plus double-width characters.

Selectable standard features on the basic printer include automatic text justification, programmable horizontal and vertical tabbing, reverse paper feed, and "fine positioning" of characters to 1/120 inch. Up to four different 96-character sets can reside within the printer at the same time, although the basic unit is provided with only one 96-character set.

The Prism is microprocessor controlled, with true logic-seeking capability. It comes with a standard RS-232C serial interface as well as a Centronics-compatible parallel interface. Serial transmission rates from 110 to 9600 bits per second (bps) are switch selectable.

Six upgrade kits can be added to the printer at any time making it one of the faster printers in its price category. (As a comparison, an 80-cps printer drops to about 60 cps in enhanced mode and 40 cps in double-strike mode.) The Prism does not have a double-strike mode, although it is capable of providing it with the proper software. You can do reverse linefeeds.

External Controls

A slot on the top left side of the printer exposes the self-test switch and the power-up configuration switches—a

At a Glance

Name
Prism Printer

Use
Dot-matrix printer

Manufacturer
Integral Data Systems
Milford, NH 03055
(603) 673-9100

Dimensions
80-column: 9.1 by 15.75 by 12.4 inches (23.1 by 40 by 31.5 cm)
132-column: 9.1 by 21.6 by 12.4 inches (23.1 by 54.9 by 31.5 cm)

Features
80 and 132-column models, 24 × 9 dot matrix, bidirectional printing at 110 to 150 cps, true logic seeking, automatic text justification, programmable horizontal and vertical tabbing, 96-character ASCII set, up to four character sets coresident, microprocessor controlled, RS-232C and Centronics-compatible interfaces.

Options
Cut Sheet Feeder, Dot Plot, Prism Color, Sprint Module, additional character sets, cassette for fully automatic sheet feed.

Price
80-column, basic unit, $899; 132-column, basic unit, $1299; Options available now; Cut Sheet Feeder, $149; Dot Plot, $99; Prism Color, $399; Sprint Mode, $99. To come: Additional fonts, $99; cassette for automatic sheet feed, $399. **Note:** Until April 1, 1982 only—Special Option Package: Cut Sheet Feeder, Dot Plot, and Sprint Mode, $297.

Warranty
90-day limited

very nice touch in the design of the printer. Unlike most printers, you do not have to remove the cover or fumble with the unit to change the power-up parameters. Three switches located under this slot provide self-test on/off (a toggle switch), print-parameter controls (DIP switch S4), and form-length and serial-interface-parameter controls (DIP switch S3). The self-test switch is nonactive with the lever to the left and active (only in the off-line mode) when the lever is to the right. S4-1 and S4-2 set the character density and characters per inch (cpi), OFF-OFF sets the 5-cpi mode (double-width mode), OFF-ON sets the 16.8-cpi mode (condensed mode on most other printers). S4-3 selects 6 lpi (lines per inch) when OFF or 8 lpi when ON. S4-4 controls the automatic boundary skip (so the printer skips over the perforations on fan-fold paper) of one inch. When OFF, S4-4 disables the skip; when S4-4 is ON the skip is enabled. S4-5 is the switch TRS-80 users will be interested in. ON enables the auto linefeed on carriage return and OFF disables the auto linefeed. S4-6 controls the default setting of the Sprint Mode and is not used in the basic Prism. S4-7 controls the expanded functions (IDS's name for software control). Once again, ON enables and OFF disables software control. The functions of DIP switch 3 are shown in table 1.

A Closer Look

The Prism printer gave me several pleasant surprises. The early IDS Paper Tigers were some of the loudest printers I had encountered. When IDS engineers designed the 560—and now the Prism—they acoustically insulated the case and lowered the noise level to less than 63 dBa, a level suitable for most office environments. (By the way, the case for the Prism is identical to the one used on the 560.)

The print quality in the normal mode is excellent. Most other printers require an enhanced mode (move over ½ dot and strike again) or double-strike mode (reprint entire line) to achieve the same character quality. Furthermore, the Prism produces this type at 110 to 150 cps, and may be used in any combination. Cut Sheet Feeder, Dot Plot graphics, Prism Color, and Sprint Module upgrades are available now; special character sets and a cassette for fully automatic sheet feed will be available in the near future.

Control Line Form Length

S3-1	S3-2	S3-2	Length (inches)
Off	Off	Off	3
Off	Off	On	4
Off	On	Off	3.5
Off	On	On	7
On	Off	Off	12
On	Off	On	11
On	On	Off	8.5
On	On	On	14

Control Line Serial Data Rate

S3-4	S3-5	bits per second
Off	Off	2400
Off	On	300
On	Off	9600
On	On	1200

Selecting Parity

S3-6	S3-7	Parity
Off	Off	No parity, transmit space
Off	On	No parity, transmit mark
On	Off	Even parity
On	On	Odd parity

Table 1: *DIP switch 3, located on the top left-hand side of the printer and accessible through a slot located there, controls form length, data rate for the RS-232C interface, and the parity. Although the switch sets the default values upon power-up, they can be overridden by software commands.*

On the right side of the top of the printer are two switches and a marker plate with several indicator lights. The left switch is a three-position switch labeled FS/OFL/ONL (Forms Set/Off line/On Line). The right switch is a spring-loaded, center return (off position), two-position switch labeled FF/LF (Form Feed/Line Feed). The indicators are for fault, on line, and power on.

Software Control

Many software commands are available with the basic unit. Here is a complete rundown. A line feed, Ctrl-J or CHR$(10), causes the paper/form to advance one line vertically. A form feed, Ctrl-L or CHR$(12), feeds the paper/form vertically to the next top of form. A carriage return, Ctrl-M or CHR$(13), causes the carriage to return without a linefeed (unless S4-5 is set to auto linefeed) after printing data in the buffer. These three controls will operate regardless of S4-7's position.

Now let's take the rest by the numbers:

Ctrl-A or CHR$(1): set expanded mode (double wide).
Ctrl-B or CHR$(2): reset expanded mode.
Ctrl-D or CHR$(4): set justify mode on (left and right margins are even).
Ctrl-E or CHR$(5): reset justify mode.
Ctrl-F or CHR$(6): set printer to fixed character space.
Ctrl-I or CHR$(9): tab to next set horizontal tab.
Ctrl-K or CHR$(11): tab to next set vertical tab.
Ctrl-N or CHR$(14): do two line feeds (double space vertical).
Ctrl-P or CHR$(16): print characters proportionally spaced.
Ctrl-Q or CHR$(17): reset the deselect mode.
Ctrl-R or CHR$(18): line feed without carriage return (S4-5's position makes no difference).

Ctrl-S or CHR$(19): deselect printer (causes it to ignore data from computer).

Ctrl-T or CHR$(20): do two line feeds without carriage return.

Ctrl-Y or CHR$(25): do three line feeds without carriage return.

Ctrl-Left bracket or CHR$(27): cause the printer to enter/exit the programming mode (This is called the escape code ESC).

Ctrl-Right bracket or CHR$(29): set printer to 10 cpi.

Ctrl-Uparrow or CHR$(30): set printer to 12 cpi.

Ctrl-Underscore or CHR$(31): set printer to 16.8 cpi.

ESC F or CHR$(27)+"F": program horizontal tabs in increments of 1/120 inch (1 inch = 120, 2 inches = 240,. . . etc). CHR$(27); "F,120,240,600,$" will set tabs at 1 inch, 2 inch, 5 inch points. You can set up to 8 tab points.

ESC B or CHR$(27)+"B": set vertical tab 1 in increments of 1/48 inch. CHR$(27); "B,24" will set a ½-inch vertical tab with only one point allowed. This is ADV-1 and defaults to 8 or 6 as S4-3 is positioned.

ESC C or CHR$(27)+"C": same as ESC B but with a default value of 8, which is a 6-1pi subscript value.

ESC D or CHR$(27)+"D": same as ESC B but with a default value of −8, which is a 6-1pi superscript value.

ESC E or CHR$(27)+"E": same as ESC F but for vertical tabs (1/48-inch increments) and up to 8 values can be set.

ESC G or CHR$(27)+"G": set the absolute head position from the home position in 1/120-inch increments.

ESC H or CHR$(27)+"H": set absolute head position from top of form.

ESC J or CHR$(27)+"J": set margins—two values are required, left margin first, then the right margin (1/120 inch).

ESC L or CHR$(27)+"L": set vertical form length—two values are required, form length first and then the printable space within that length. This instruction works within the form-length switch settings (1/48 inch).

ESC P or CHR$(27)+"P": sets the intercharacter spacing in increments of 1/24 character width.

In all the above instructions, a "$" is required as the last character to terminate the instruction. Tabs may be cleared by setting a single tab to 0: CHR$(27);"E,0,$" clears the vertical tabs and CHR$(27);F,0,$" clears the horizontal tabs. (I have deliberately not put the PRINT statement in these examples due to the variety of forms it can take. With the Apple computer you open the printer port and then use PRINT statements. With the TRS-80 you have to use LPRINT statements.)

Options

The $149 Cut·Sheet option (what I call letterhead) adds friction feed to the Prism printer. Most printers that have a friction option force you to feed the paper from the top and manually advance it to the position where you want

Fig. 1A

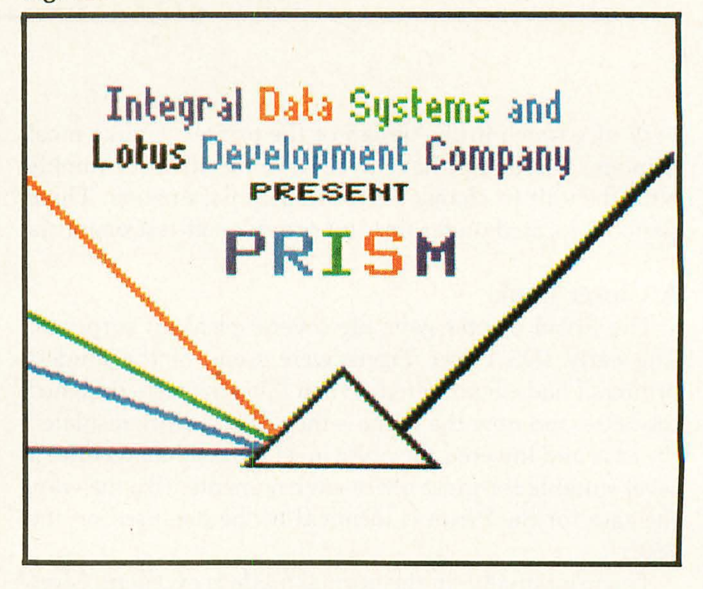


Fig. 1B

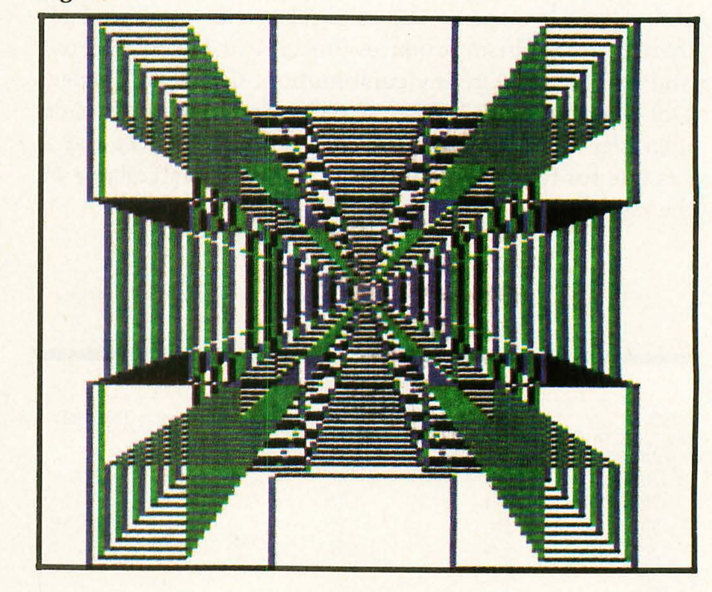
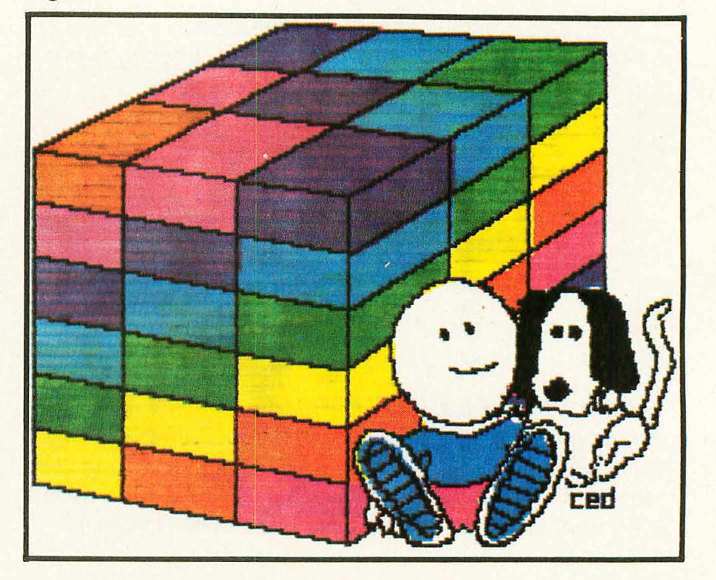


Fig. 1C



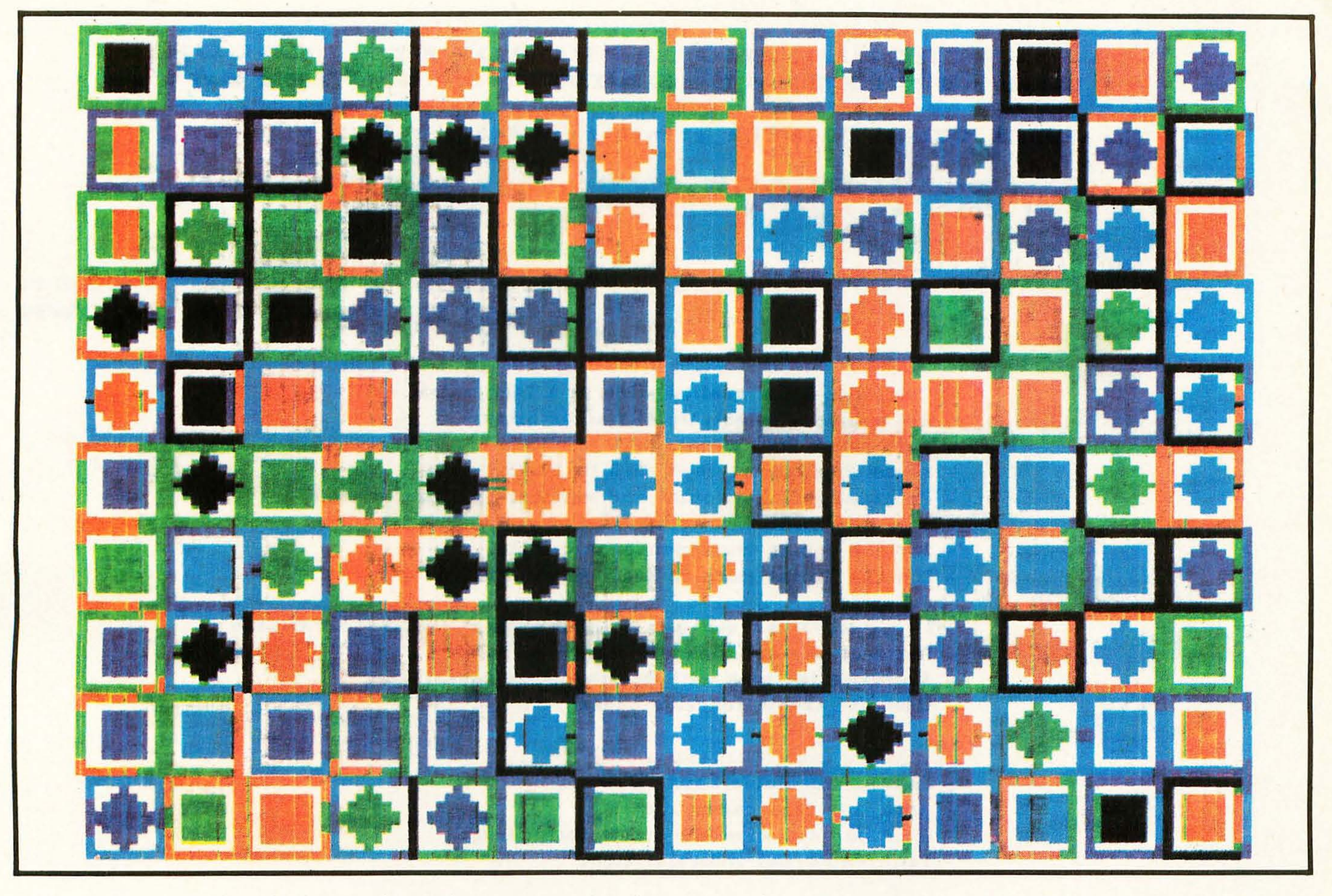


Figure 1: *Four examples of color graphics. These were produced on a 132-column Prism printer with the Dot Plot and Prism Color options and the process-color ribbon. Graphics are dot addressable.*

to start printing. If you are good at it, you won't have to square up your sheet. It is also very difficult trying to print to the bottom of the page with other friction-feed printers. The Prism's Cut Sheet option shows the same care in design as the rest of the unit. You can feed the paper from either the back or front of the printer. A photo sensor detects the paper being inserted. After a one-half- to one-second delay, the pinch rollers start to revolve, and if you have inserted the paper correctly it will feed and position the sheet to the first printable line on the paper. You might have to manually line feed past your letterhead, or you can handle that with your word-processing software. You will have to adjust the tractors on the printer to allow the paper to feed through them with the pins just to the outside of the paper. IDS has placed a set of pinch rollers into the tractors that are driven by the normal tractor-feed mechanism and continue to feed the paper after the bottom pinch rollers have been passed. With the out-of-paper sensor located at the print head level, this allows the printer to print clearly and evenly right to the last line on the page. A simple form feed will eject the letter completely from the printer. Very nice indeed for the office that does a lot of letters on standard letterhead bond.

Dot Plot is a $99 dot-addressable graphics option package. The density is 84 by 84 dots per inch (dpi) for single-pass raster and 168 by 168 dpi for a four-pass raster. This option adds more control codes for you to play with. To enter the graphics mode you set switch S4-5 to ON and send a Ctrl-C (CHR$(3)). You can also select unidirectional (default) or bidirectional graphics by sending Ctrl-L or Ctrl-V, respectively. To exit you use a Ctrl-C + Ctrl-B (CHR$(3);CHR$(2);). In the graphics mode you have to be careful to always end your BASIC instruction line with a semicolon to prevent the automatic generation of carriage returns and linefeeds, as these would be printed as graphic characters and mess up your picture. Seven wires of the print head are used in the graphics mode and are bit controlled. Bit 0 controls the top wire and bit 6 controls the bottom wire. Bit 7 is ignored. You also have vertical and horizontal control if you use the previously given codes prefixed by CHR$(3).

Prism Color is a $399 color-capability option that adds color designator control codes to your instruction set. The printer that I reviewed did not have this option, so my assumptions are based on the color ribbons that I saw. You will have a choice of three ribbons: black plus process colors for mixing, black plus primary colors, and

INTRODUCING AFFORDABLE COLOR
The INTEGRAL DATA PRISM™ Printer

The PRISM COLOR PRINTER prints four basic colors :

COLOR #4=BLACK
COLOR #2=MAGENTA
COLOR #3=CYAN
COLOR #1=YELLOW

AND CAN MIX COLORS :
MIX #1+#2, ORANGE
MIX #2+#3, VIOLET
MIX #1+#3, GREEN
MIX #2+#4, BROWN

Versatile Printing Capabilties
- Correspondence quality print in a 24x9 matrix cell
- Six software selectable character sizes
- Auto sheet feed mechanism
- Adjustable tractor feed, 5.0 to 14.75 inches
- Programmable horizontal and vertical tabbing
- 6 or 8 lines/inch spacing
- 110-150 cps in correspondence quality
- 200 cps Sprint Mode in draft matrix quality

Microprocessor Driven Controller
- State-of-the-art technology
- Versatile features with programmable capabilities
- User defineable function codes

Ease of Operation
- Switch selectable baud rates
- Auto line feed capability
- Hardware/software selectable forms length
- Fault/Paper-out indicator light

Ready Serviceability
- Simple mechanisms for easy service
- Modular design provides for low MTTR
- Built-in diagnostics and Self-test mode

Interfaces for All Configurations
- Parallel (Centronics compatible)
- RS-232c (up to 9600 bd) with Xon/Xoff protocol
- 115/230 volts, 50/60 Hz power, switch selectable

DotPlot Graphics Capability
- High resolution raster graphics
- 84x84 dots/inch
- Includes 1500 byte character buffer
- Long-life cartridge ribbon system



INTEGRAL DATA SYSTEMS
Milford, N.H. 03055
(603) 673-9100

Figure 2: *Combining color with text. Color adds a new dimension to reports, manuscripts, and other documents. Combined with Dot Plot graphics, the possibilities are endless.*

(3a)

```
 !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmno
pqrstuvwxyz{|}~▦ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
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pqrstuvwxyz{|}~▦ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
`abcdefghijklmnopqrstuvwxyz{|}~▦ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNO
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0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~▦
```

(3b)

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 !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmno
pqrstuvwxyz{|}~▦ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
`abcdefghijklmnopqrstuvwxyz{|}~▦ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNO
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0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~▦
```

Figure 3: *A comparison of normal and draft print. Figure 3a shows the normal, correspondence-quality print, monospaced, at 10 cpi. Figure 3b shows the print produced by the Sprint Mode option. In this mode, the printer zooms along at 200 cps.*

all black for standard printing. The printer I am using has the ribbon set at an angle, allowing the head to start at the top and finish at the bottom of the ribbon. This has the effect of using the entire surface of the ribbon for the expected 10-million-character life. The character life expectancy of the color ribbons should be less, due to the fact the ribbon will be set horizontally. This is necessary for the head to encounter the same color strip on the ribbon during its full travel. The colors are stacked in stripes over the black, which means the ribbon must be positioned to place the proper color in front of the head for each pass. There can be up to four passes of the head for each line feed: top color, next color down, next color down, and black, which is the last color stripe on the ribbon.

The Sprint Mode option is available for another $99. This option is controlled by S4-6 and is enabled with the switch ON. It gives what IDS calls rough-draft printing. The print quality is that of most other dot-matrix printers in single-pass, unemphasized mode. The difference here is that the Prism does it at 200 cps (see figure 3). This mode can be entered via software and is also switch selectable. To change the default setting, turn off the printer, change the position of S4-6, and turn the printer back on.

Optional character sets should become available in the summer of 1982. For $99 each, you will be able to have Helvetica, scientific notation, and others. All the special symbols necessary to print in the six major European character sets are standard in the basic printer.

The last option (to be available soon) is a $399 cut-paper-feed cassette. Here the machine will really outdistance the field of friction/tractor printers in the $2000-and-under class, as it is the very first one to offer this option. By combining this printer, a word processor, and a mailing list that works with the word-processor files, you will be able to do individualized form letters to your mailing list on your letterhead. Now that is real class compared to most of the form letters that I get in the mail.

Examples of what can be done with the Dot Plot and Prism Color options are shown in figure 1. Figure 2 shows how text, color, and graphics can be combined.

Conclusions

Integral Data Systems has developed a new breed of printer. Its designers are to be congratulated for the quality of their product, the workmanship, and their innovative spirit.

- I like the design philosophy, execution, and price. For the money, it's hard to beat.
- You don't have to buy more printer than you need. Options can be added later.
- The documentation is excellent, providing complete setup, test, troubleshooting, and maintenance procedures, as well as complete schematics.
- IDS provides a 90-day limited warranty on all its products. It is presently expanding its service organization. ■

Use Voiceprints to Analyze Speech

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Do you ever talk to your computer? I do. But it doesn't understand a word I say. That's just as well right now, because I talk to it mostly in moments of hardware-induced frustration.

Of course, the computer talks to me. If you've read my June and September 1981 Circuit Cellar articles, you know that my computers can talk using two different methods of voice synthesis. At present, a computer can synthesize speech much more easily than it can recognize speech.

Professional speech-recognition systems currently on the market can cost up to $100,000. Budget-priced systems for personal computers are available for about $500, but of course, they don't perform as well.

My mail has been full of requests from readers for a speech-recognition circuit. Most correspondents point out that such a project is a natural follow-up to the two articles on voice synthesis. Unfortunately, designing a cost-effective voice-input speech-recognition system is a major project; it not only requires a complete understanding of the techniques involved but also necessitates skills in the design of filter networks and intricate data-comparison algorithms.

The basic concept of speech recognition is rather simple: have a computer digitize the analog voice waveform of each spoken word and compare it to a stored reference vocabulary. A basic block diagram is shown in figure 1.

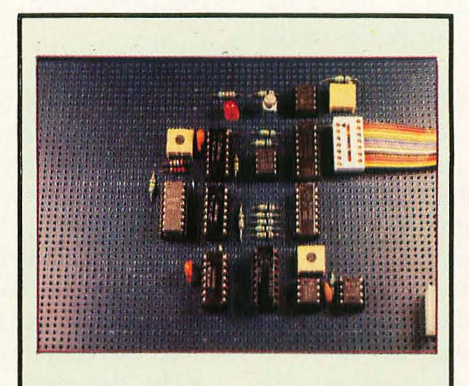


Photo 1: *The sample and scanning circuit of figure 5b, constructed on a breadboard.*

First, the analog voice input is amplified, then it is digitized to form a *word template.* This template formatting can be done by various techniques that include bandpass filters, A/D (analog-to-digital) converters, zero-crossing detectors, or fast Fourier analyzers. The result, whatever the technique, is a digital representation of the word spoken into the microphone. In an inexpensive speech-recognition system, this word template might be 10 bytes long, whereas in a $100,000 system the template may have 10K bytes of data per word.

The input word template is then processed by a computer and compared to a series of templates stored in memory. The stored templates constitute the machine's vocabulary. A spoken word is deemed to be recognized when there is an exact or reasonably close match with one of the stored templates.

In practical speech-recognition systems, the size of the word template must be traded off against the amount of available memory or storage and the computing power of the processor. With a small template, the

words are not very well defined, and there is a considerable possibility that the computer will confuse two different words. On the other hand, large templates, which more precisely define the words, take considerably more time for comparison as well as more storage space.

To achieve reasonably fast recognition with large templates, the computer must digest information at prodigious speed. In professional speech-recognition systems, a typical processor might perform 1 million 16-bit by 16-bit multiplications per second. Creating such a number cruncher is expensive.

To build a speech-recognition system on a low budget, using a microprocessor, we must make some compromise either in the time allotted for the computer to recognize a word or in the precision with which words are defined in the templates. There must be some amount of storage between 10K and 10 bytes that defines a word sufficiently well for our low-cost speech-recognition system to recognize it within a tolerable duration.

Preliminary Research

This article doesn't tell you how to build a speech-recognition system. We aren't ready for that yet. Instead, it describes a scheme to analyze the audible content of speech so that we can more accurately define a suitable template size.

A definition of just how much data is required can be determined only by carefully examining the spectral content of speech and analyzing the differences between the words we want to have the computer recognize. Just what is the audible difference between the numbers "six" and "eight"? Is there a unique set of data points that allows them to be easily differentiated?

In essence, the information we are looking for is a kind of fingerprint for speech, a *voiceprint.* (It may also be called a *spectrogram.*) By visually comparing the spectral voiceprints of words, we can perhaps come to understand details of definitive templates and the workings of comparison algorithms.

We may find that in a limited-vocabulary speech-recognition system the spectral differences between the words in the selected recognizable set may be so distinct that the template resolution can be reduced to perhaps less than 100 bytes. It is also possible that such an examination will demonstrate that a monumental effort must be exerted to distinguish between two words such as "seem" and "seen."

I hope to eventually write about a voice-response speech-recognition system. Such a project seems to lie within the scope of a Circuit Cellar article. For the present, however, I am still researching certain information about the significant differences between words, seeking to answer such questions as: Must data on amplitude as well as frequency be recorded? Must the input word be digitized in real time? Can the stored template data be compressed in some way? What frequencies are important and which can be ignored? Is there much variation between different utterances of the same word?

This month's hardware project, a spectral voiceprint display, should help answer some of these questions.

What Are Voiceprints?

When you speak, the sound that comes out of your mouth is composed of various frequencies blended together to create the tonal quality that is unique to your voice. If you attach a microphone to the input of an oscilloscope and speak into it, you can watch the frequency and amplitude changes. The bandwidth of meaningful sounds for most voices is about 4 kHz. (Not coincidentally, this is the passband of a voice-grade telephone line.)

Another method of looking at the various frequencies present in voices is to produce a graph of speech waveforms showing frequency as a function of time. An example of this is shown in figure 2 on page 52. As the word"eight" is spoken, the majority of the energy is between 1 and 4 kHz

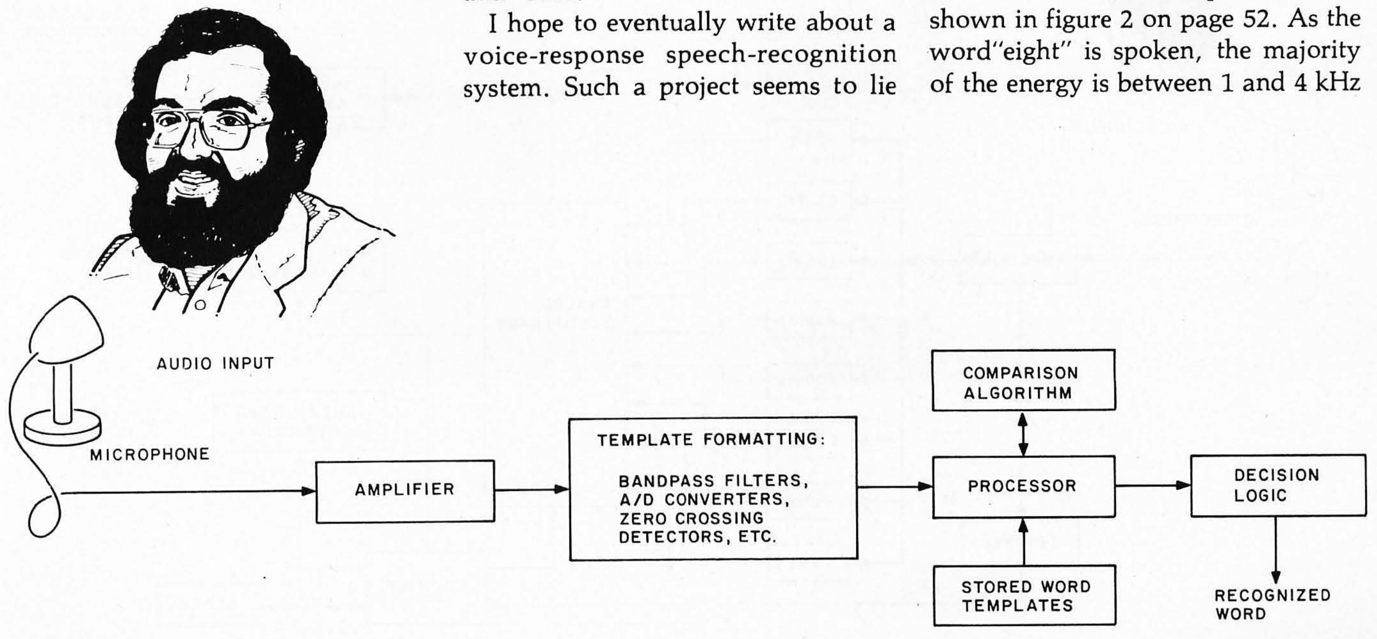


Figure 1: *Block diagram of a computer speech-recognition system using word templates.*

for the first 0.15 seconds, then a silent period is interrupted after another 0.15 seconds by a quick burst of energy at about 4 kHz. The first waveform group is the "eigh", and the final burst is the "t". A plot of the amplitude also provides significant information.

This sort of voiceprint or spectrogram shows a record of frequency and amplitude versus time.

Producing the graph shown in figure 2 requires an x,y plotter and a real-time spectrum analyzer. This equipment is costly and not generally available to the average experimenter, but with a little ingenuity we can obtain similar results with some simple bandpass filters and an oscilloscope.

Economy Voiceprint Display

The laboratory spectrum analyzer typically used to produce voiceprints often contains either a scanning filter or FFT (fast-Fourier-transform) processor. Such equipment has extremely high resolution (as well as cost) and allows the operator to resolve frequencies separated by only a few hertz (Hz). This is much more resolution than is required for our application, and a more cost-effective real-time spectrum analyzer can be substituted.

Figure 3 is a block diagram of the hardware I used to record voiceprints. It consists of an eight-octave bandpass filter connected to a microphone and some timing circuitry. The outputs of the circuit are connected to the x-axis, y-axis, and blanking (z-axis) inputs of an oscilloscope. The result is a three-dimensional view of the spoken word. The x axis represents time, the y axis represents frequency, and the z axis (brightness) represents amplitude.

The plot thus produced looks somewhat different from the spectrogram in figure 2, but it is equally representative of spectral content. The eight filter sections cover eight octaves from 31 Hz to 4 kHz. Concentrations of energy in the eight octaves appear as eight bands across the display.

For example, if there are any frequencies present around 1 kHz, the 1-kHz band on the display is illuminated, appearing as a stripe across the oscilloscope screen. The amplitude of these frequencies governs the intensity of the stripe. If this approximately 1-kHz signal is weak, the pattern will be dim; if it is strong, the pattern will be bright.

Figure 4 is an example of the kind of display produced by my interface circuit. This is approximately how the word "eight" appears when spoken. You'll note the grouping of energies corresponding to "eigh" and "t" as before. (There is also a shift in frequencies due to the fact that this display was produced by a different

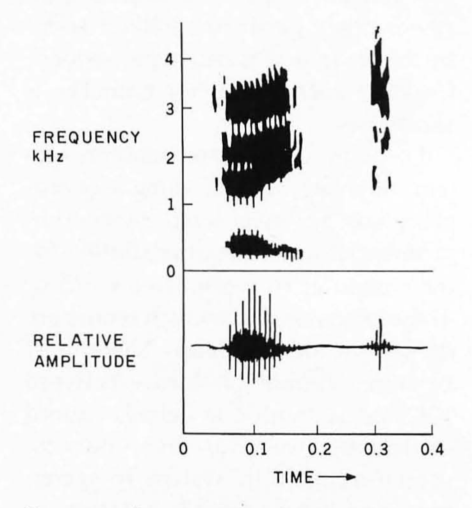


Figure 2: *A conventional voiceprint, or spectrogram, of a man saying the word "eight." Frequency is plotted as a function of time.*

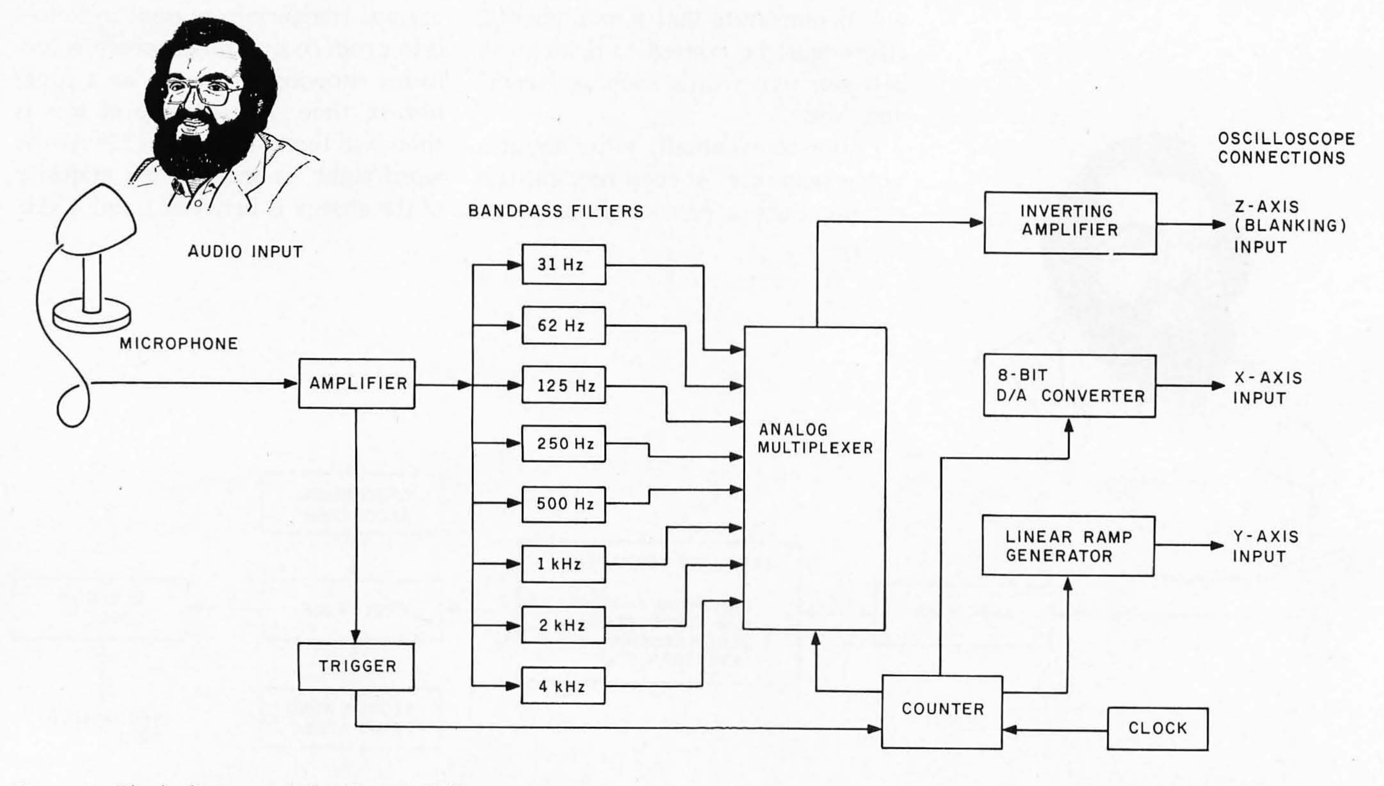


Figure 3: *Block diagram of the Circuit Cellar voiceprint-recording system.*

person speaking.) While unlike the ink-drawn spectrogram, it is equally detailed and unique.

On an 8- by 10-cm (centimeter) oscilloscope display, each frequency band occupies 1 cm on the vertical (y) axis. Time is recorded on the horizontal (x) axis where 1 cm corresponds to 0.05 seconds (all screen photos accompanying this article have these values). A complete word sample therefore represents sounds occurring during a one-half-second interval, consisting of 128 samples at each frequency. Changing the clock rate of the circuit can increase or decrease the scan time.

The scans appear as vertical lines on the screen. A full half-second sample consists of 128 vertical filter scans. Each vertical scan is divided evenly into eight sections corresponding to the eight filters. The bottom is 31 Hz, and the top is 4 kHz. The intensity of each segment of the scan line is determined by the output voltage of the particular filter: the more positive the output, the brighter the segment. If there is no output from a filter section during a segment interval, that portion of the segment will not be illuminated (it will be blanked). As configured, a half-second sample period scans the filters every 3.9 ms (milliseconds).

How the Display Circuit Works

Figure 5 is a schematic diagram of the voiceprint-display system. It is basically divided into two sections: amplifier and filters (figure 5a on page 56) and the sample and scanning logic (figure 5b on page 58). A prototype of the sample and scanning logic is shown in photo 1 on page 50. The ribbon cable leads off to the amplifier and filter board.

Integrated circuit IC1 is a two-stage microphone preamplifier (you could substitute a much simpler circuit; this just happens to be the one I used) feeding output into IC2b, which has a sensitivity adjustment potentiometer and an additional stage of amplification. IC2a is an average level indicator. While each filter responds only to its preset frequency passband, this portion of the circuit passes all frequencies and produces a DC voltage output proportional to the average volume level. This output is fed to the voltage comparator IC9, which switches when the average input level is above a certain amplitude, thus triggering the sample period when pronunciation of the word begins.

Integrated circuits IC3 through IC6 are configured as eight separate bandpass amplifiers with center frequencies at 31 Hz, 62 Hz, 125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, and 4 kHz. The filters are not particularly sharp, possessing a frequency rolloff of about 8 dB (decibels) per octave. The output stage of each filter contains an integrator that converts the pass frequencies into an average DC level.

The timing network appears more complicated than it is. For a half-second word sample the clock rate is set for 4096 Hz and is divided down through an 11-bit counter configured from IC14 and IC15. The reset lines of the counters are controlled by the trigger-level comparator IC9 and an RS (set-reset) flip-flop formed from IC7, sections c and d. When the circuit triggers, the reset line on the counters is raised to a logic 1, and they begin to count. After 2048 clock cycles, the flip-flop is reset and the scanning is stopped. A timing diagram is shown in figure 6 on page 60.

The 3 least significant bits of the counter control the address lines of an 8-channel analog multiplexer, IC16. The eight inputs of the multiplexer are the eight outputs from the filters, and the output of the multiplexer goes to the oscilloscope. When the multiplexer address is binary 000, the 31-Hz filter output is channeled through it to the scope blanking input, where it controls the oscilloscope-beam intensity. Similarly, binary 111 addresses the 4-kHz filter. (While this eight-cycle scan occurs every eight clock periods, it is displayed only at alternating scans.) The other 8 bits of the 11-bit counter set the 256 positions of the x axis (128 displayed and 128 blanked positions).

(The output level of the multiplexer should be set for the blanking range of your particular oscilloscope. This can be either a positive or negative voltage. My oscilloscope, a Tektronix model 2215, requires a negative blanking voltage, so I added IC10 as an inverting amplifier.)

Since an oscilloscope is an analog device, the digital counter outputs must be converted to analog voltages. Two different methods are employed in this circuit. The 8 most significant bits of the 11-bit counter drive an

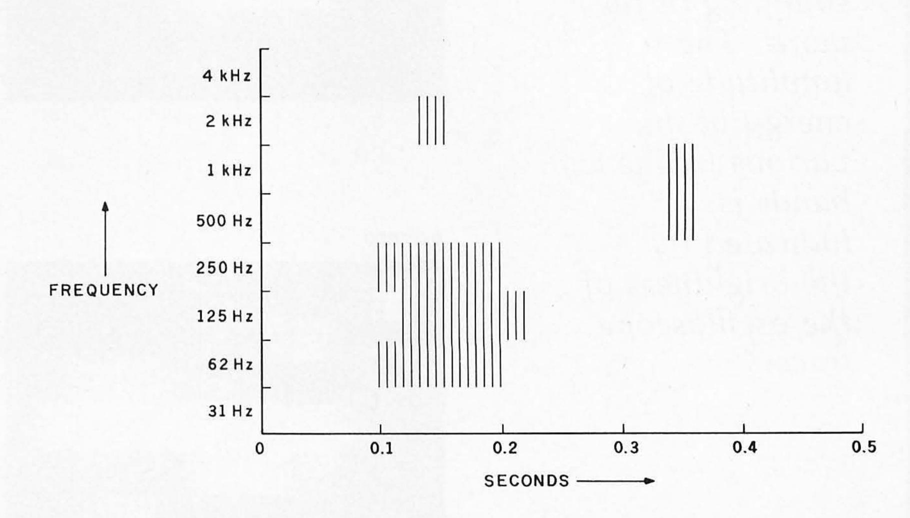
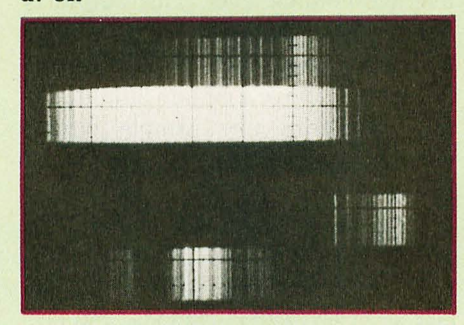


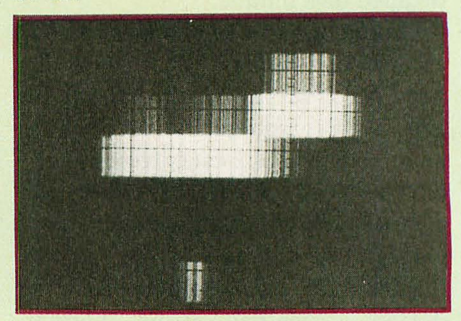
Figure 4: *Typical display produced by the Circuit Cellar voiceprint system, of the word "eight." Although dissimilar in appearance to the conventionally plotted spectrogram of figure 2, it contains the same kind of information, along with indications of amplitude through modulation of the intensity of the scanning beam.*

Photo 2: *Voiceprints, or spectrograms, of various words being pronounced by a Micromouth voice synthesizer, as recorded by the circuit of figures 5a and 5b attached to a Tektronix model 2215 oscilloscope. Eight frequency bands are defined in the vertical y axis, while the horizontal x axis gauges time elapsed during the sounding of the word. The amplitude of energy in the various frequency bands is indicated by the brightness of the oscilloscope trace.*

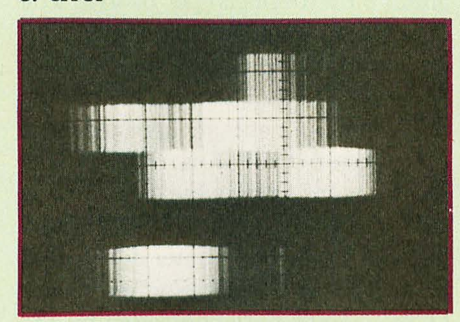
a. on



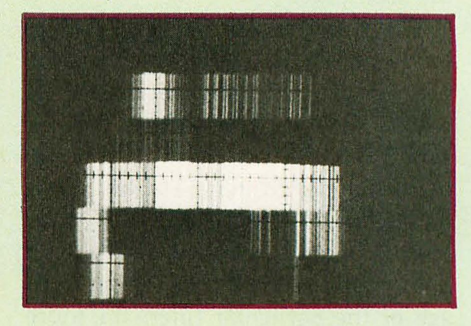
b. off



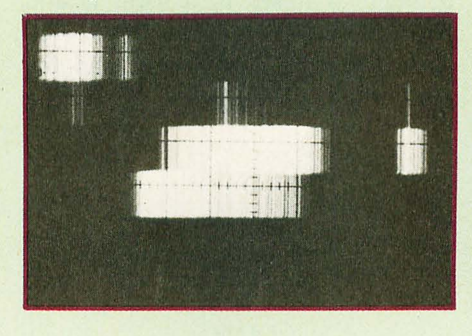
c. error



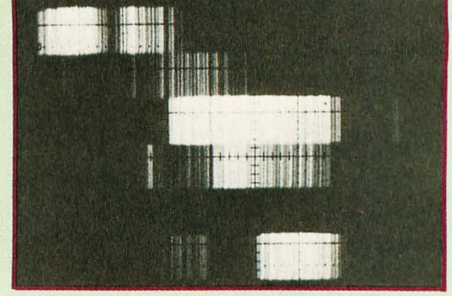
d. ready



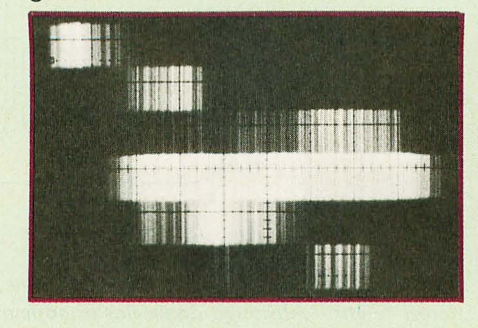
e. stop



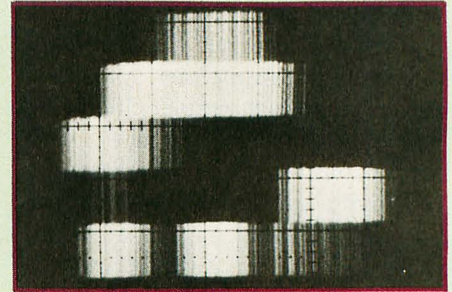
f. start



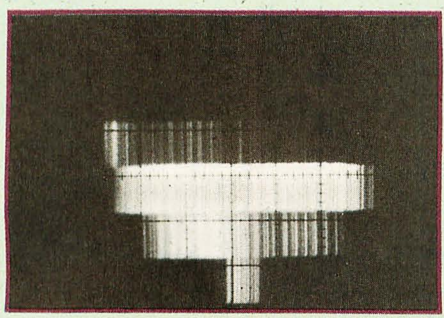
g. zero



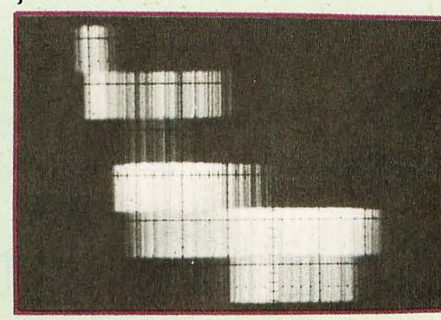
h. one



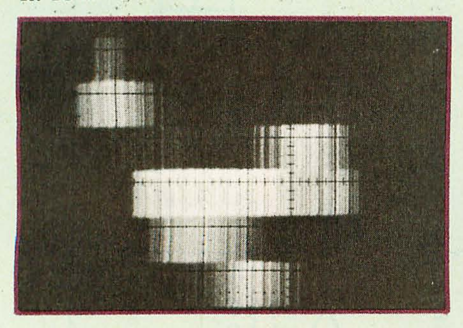
i. two



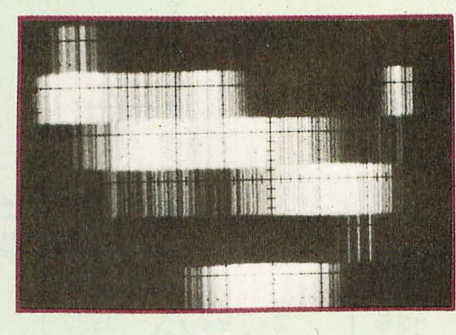
j. three



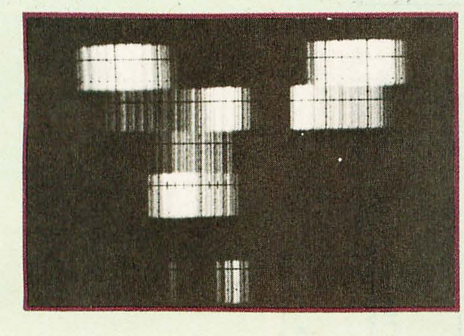
k. four



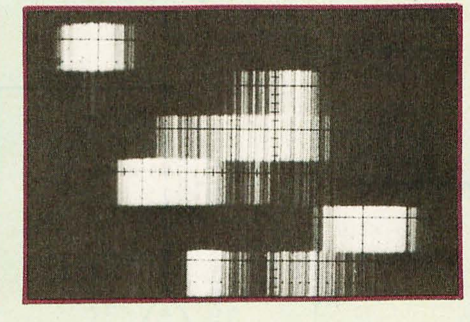
l. five



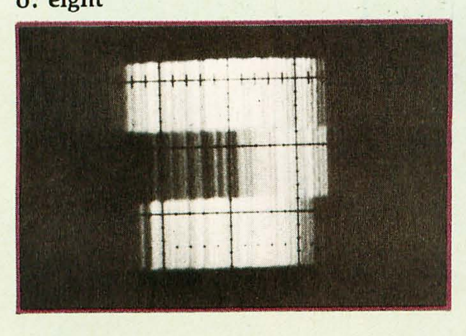
m. six



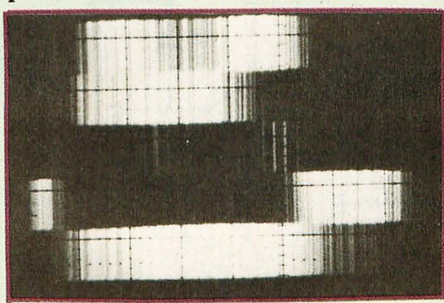
n. seven



o. eight



p. nine



R-2R-ladder D/A (digital-to-analog) converter, which I discussed in my January Circuit Cellar article. With a count of 0, the output is 0 V (volts); with a count of 255, the output is +5 V. Therefore, each step is 19.5 mV (millivolts).

With a clock rate of 4096 Hz, the D/A converter increases its output voltage by an increment of 19.5 mV every 2 ms. With the scope set for x,y-vector display mode, the x-axis scope trace proceeds from the bottom left corner (0 V) to the bottom right corner (+5 V), taking half a second.

Initially I used a 3-bit D/A converter to increment the position of the y-axis beam. However, the 60-MHz bandwidth of the Tektronix scope was sufficient to cause each vertical scan to appear as eight dots rather than eight line segments. The scope was too fast. This was remedied by using a ramp-function generator configured from IC11 and IC17. IC11 is a positive-going integrator, and IC17 is a shorting switch connected across the integrating capacitor.

When the switch is closed, the output of IC11 is 0 V. This is the case during the odd-numbered scans, when the Q4 output of IC14 is high. On even scans the switch is open, and the capacitor is allowed to charge. As configured it charges linearly at a rate determined by the slope-adjustment potentiometer. This potentiometer should be set so that the output of IC11 (pin 6) goes from 0 V to 12 V during the 2-ms half period of the Q4 output. The clock rate affects this time period, so the slope will have to be readjusted if the clock frequency is changed.

Recording Voiceprints

After connecting the voiceprint-generating system to the scope, you can begin to experiment. Speak a word into the microphone. The beam will be triggered, and the trace will move from left to right across the screen. Slowly increase the input-sensitivity potentiometer until the background noise saturates the display. All filters will have some output, and the screen will be completely unblanked. Slowly back off

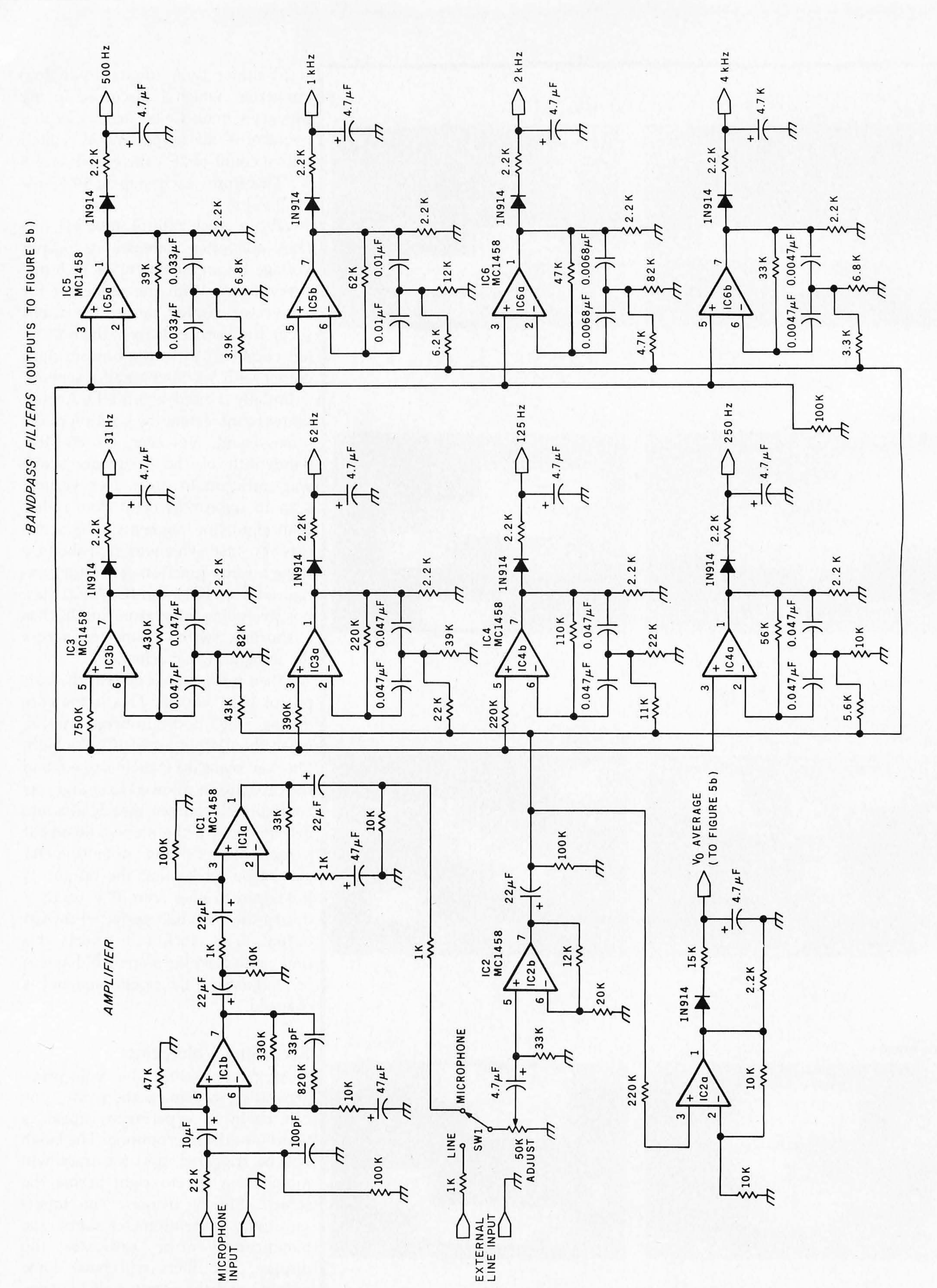


Figure 5a: *Section of the schematic diagram of the spectral voiceprint circuit, showing the amplifier and bandpass-filter components. Eight passbands are selected by the filter stages, with the output sent to the scanning and display section of figure 5b.*

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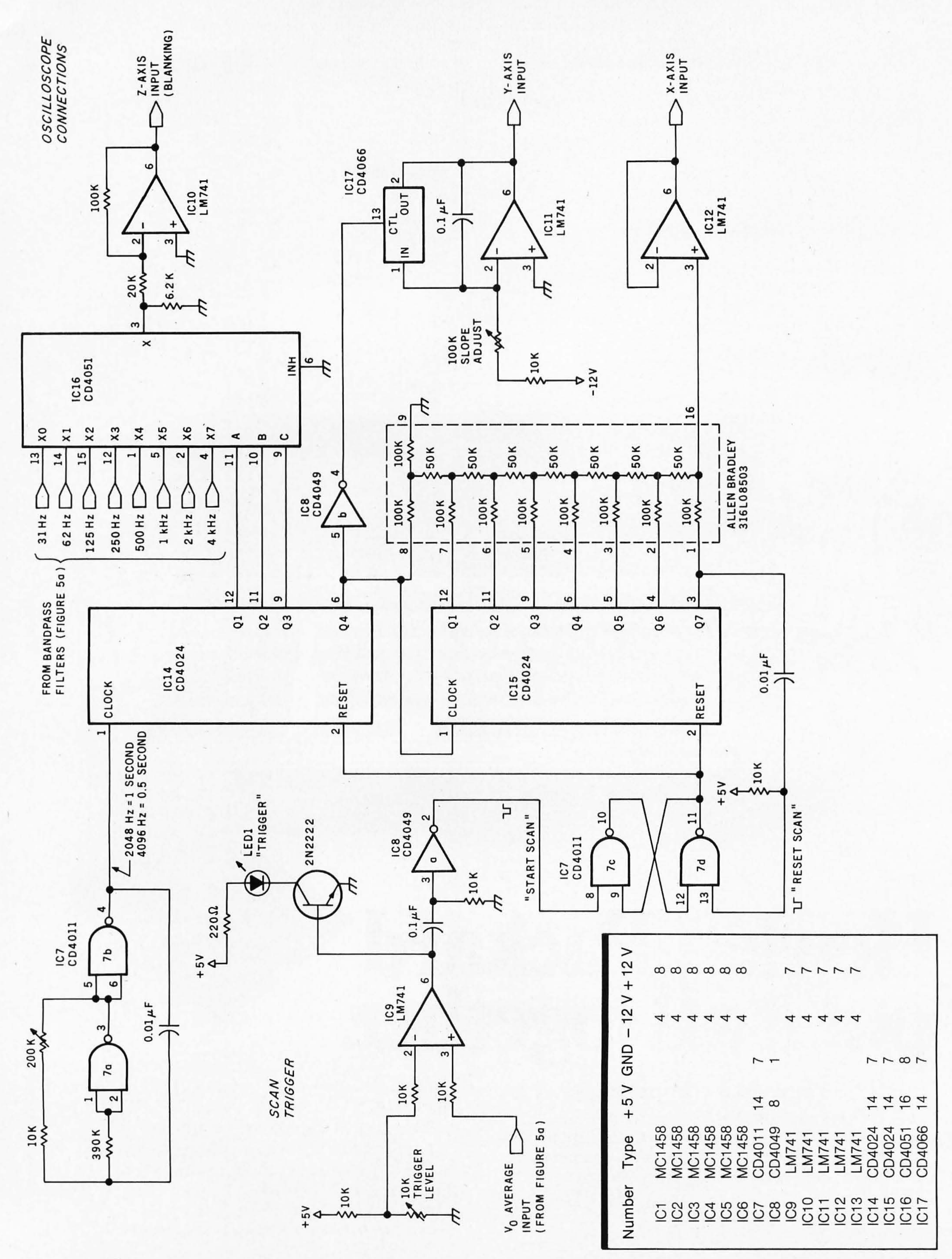
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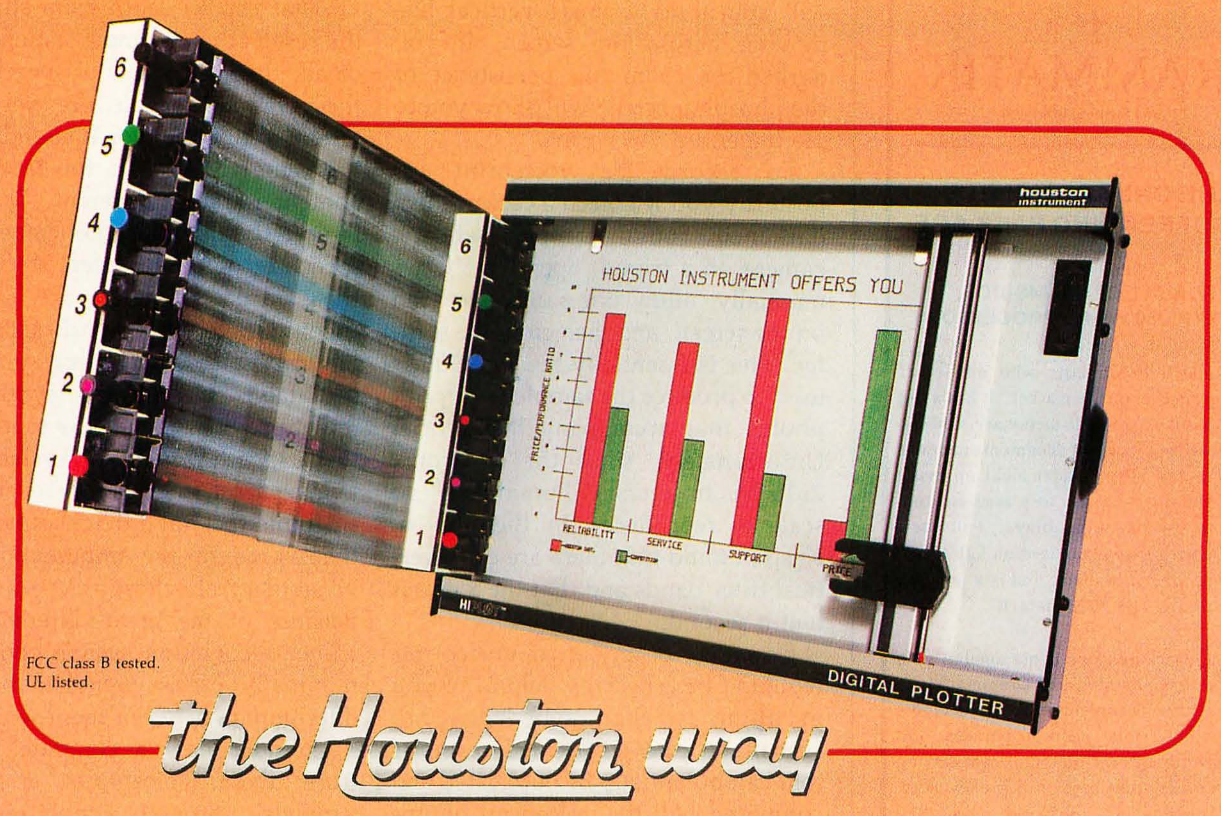




Number	Type	+5 V	GND	−12 V	+12 V
IC1	MC1458			4	8
IC2	MC1458			4	8
IC3	MC1458			4	8
IC4	MC1458			4	8
IC5	MC1458			4	8
IC6	MC1458			4	8
IC7	CD4011	14	7		
IC8	CD4049	8	1		
IC9	LM741			4	7
IC10	LM741			4	7
IC11	LM741			4	7
IC12	LM741			4	7
IC13	LM741			4	7
IC14	CD4024	14	7		
IC15	CD4024	14	7		
IC16	CD4051	16	8		
IC17	CD4066	14	7		

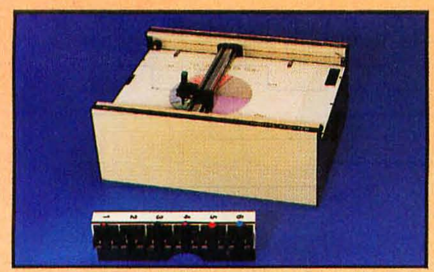
Figure 5b: *The scanning and display section of the voiceprint circuit, shown in schematic form. Input comes from the bandpass filters, and output is sent to an oscilloscope. Discrete resistors may be used in place of the Allen-Bradley 316L08503 resistor package.*

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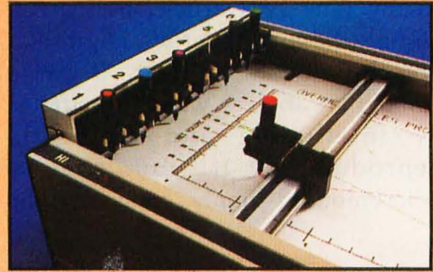
FCC class B tested.
UL listed.

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the gain until the display appears to respond as you speak a word. Continue this adjustment until the display looks like the sample photos.

In bright ambient light the display will appear as a single vertical line moving across the screen. If you darken the room, the persistence of the phosphor screen will allow you to see the entire voiceprint.

To record the voiceprint for posterity you will need a camera. In a darkened room, simply set the camera on a tripod, open the shutter manually, allow one sample to scan on the screen, and then close the shutter. This is essentially the technique I used to produce the sample voiceprint photos that accompany this article. Unfortunately, since the Tektronix 2215 has no reticule illumination, no scale is reproduced in the photos. Keep in mind that there are eight vertical filter bands and that the x axis is half a second.

Examples of my own voiceprints wouldn't be especially helpful to you in trying to align your voiceprint system, so I have provided examples that can potentially be duplicated and compared. All the voiceprint photos here were produced using the output of a Micromouth voice synthesizer. The Micromouth, which I described in my June 1981 article, uses a National Semiconductor Digitalker speech-synthesis chip set. It has a limited vocabulary which is extremely intelligible and eminently reproducible. If you have a Micromouth, simply connect it up and compare your results to the various prints of words and numbers shown here.

Experimental Results

What can we learn from studying the results of our simple testing? First of all, the voiceprints of speech synthesizers and people are very different. While the words sound much the same to the ear, the frequency content is rather different. This difference should not bother a computer speech-recognition system so long as the word templates are set to recognize either synthesized or natural voices. But because of its repeatable speech, the synthesizer might provide a good way to initially test a speech-recognition system.

In general, there seem to be considerable spectral differences between the words in the minimum useful vocabulary I chose as examples. Because of the great differences, a speech-recognition system could use minimally precise template data to differentiate between these words.

Consider how a computer could store these voiceprints as word templates. An A/D converter could be used to read the filter values. Storing the output values from 128 scans of eight filters requires 1024 (1K) bytes for each word, assuming the use of an 8-bit A/D converter. The amount of memory required can be reduced by eliminating the dead air time at the beginning of words and between the sounds contained within a word.

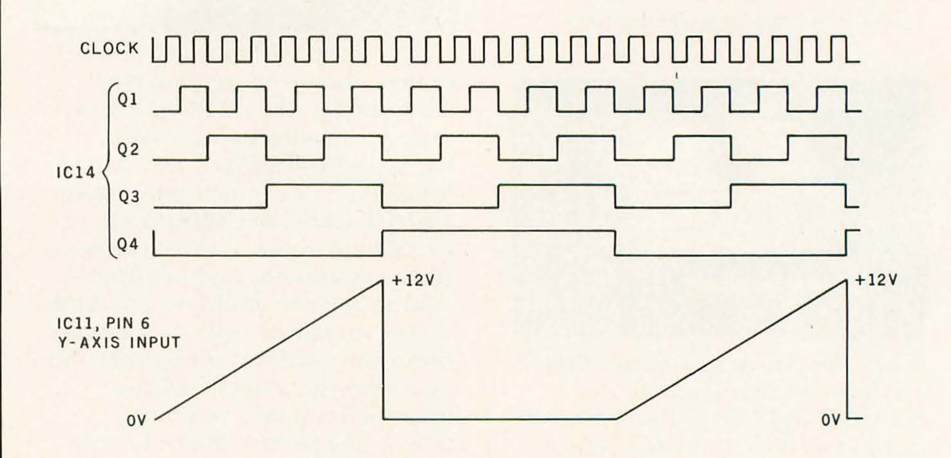


Figure 6: *Timing diagram of the voiceprint-recording system.*

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Perhaps storing the output amplitude of the filters is unnecessary, and a simple threshold detector would be sufficient. A logic 1 could indicate that there is some spectral content in that frequency range while a logic 0 indicates none. The eight instantaneous filter outputs could then be stored in a single byte rather than eight. This translates into a memory requirement of 128 bytes per sample period. This presumes that information about the frequency content of speech with respect to time is more important than information about the amplitude of the energy in the different frequency bands. I think it will depend a lot upon the vocabulary chosen.

Finally, I saw little activity in either the 31-Hz or the 4-kHz band in speech both from my own voice and from the Micromouth. This may be a limitation of the hardware, but I think it would be safe to eliminate these passbands from any voice-response system. In my experience, the three frequency ranges that seem to always contain the most energy are about 60 Hz to 200 Hz, 200 Hz to 500 Hz, and 1 kHz to 2 kHz. I am at present unwilling to design a speech-recognition system with only three sampling passbands, but I'm still gathering data.

In Conclusion

I haven't yet decided how I will configure my speech-recognition system. I have only one major design criterion so far: because writing comprehensive software algorithms isn't among my greatest pleasures in life, I will attempt to do as much in hardware as I can.

Perhaps if I stall long enough a few inexpensive integrated circuits that can do it all will emerge from Silicon Valley. I have heard promising reports on a few such products. I know of the intense interest many of my readers have in the subject, and I intend to build a speech-recognition system as soon as I can make it cost-effective.

I hope that this article has at least helped you understand some of the first steps in speech recognition. If you are talented in software, you may have been inspired with an idea that will make the process easy. But at any rate, I hope to have helped allay any suspicions that computerized voice response is a black art.

Next Month:

New technological developments have made infrared light a convenient medium for remote-control or data transmission. We'll explore how to use it. ■

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Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Most of these past articles are available in reprint books from BYTE Books, 70 Main St., Peterborough, NH 03458.* Ciarcia's Circuit Cellar, Volume I, *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II, *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III, *contains the articles that were published from July 1980 through December 1981.*

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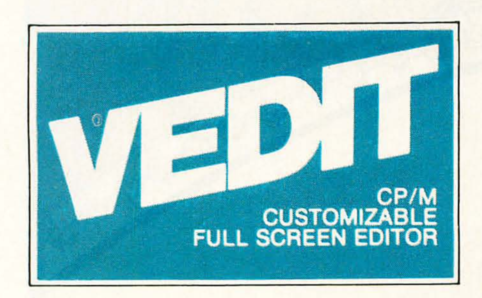
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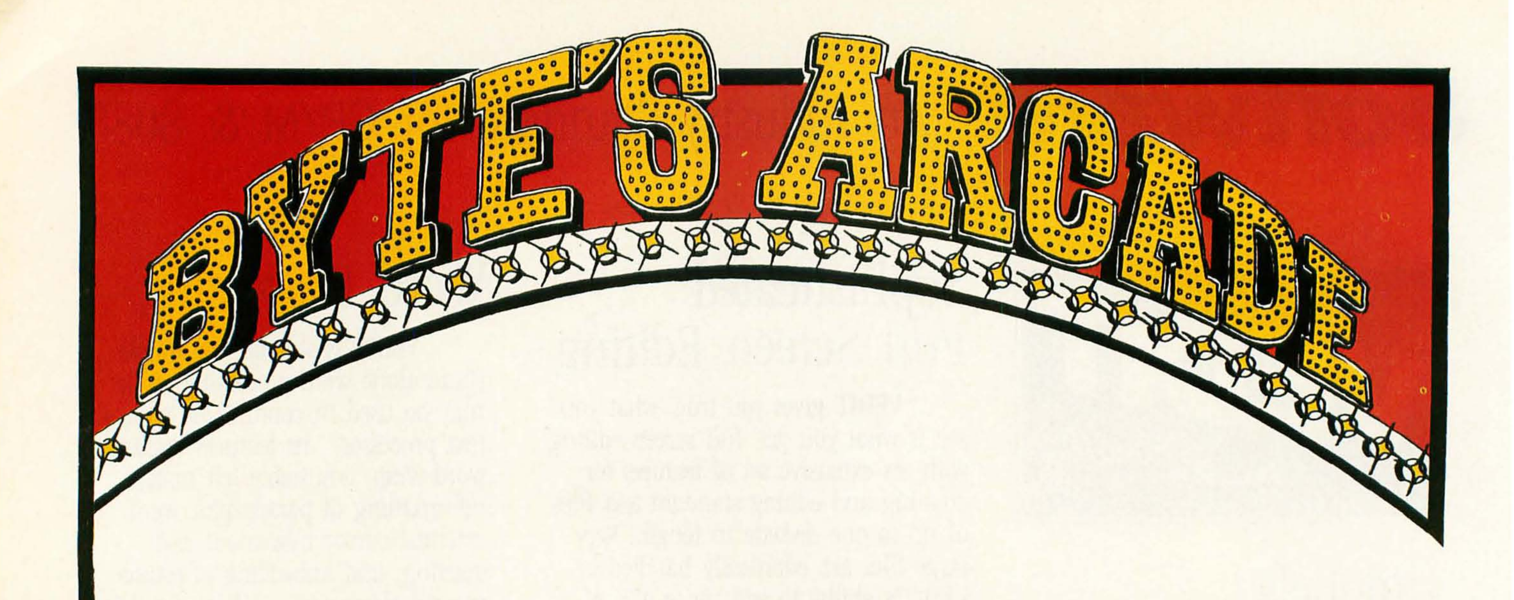
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Apple Panic

Gregg Williams
Senior Editor

Personality—it's a major factor in distinguishing arcade best-sellers from the ones that lie around gathering dust in a corner. In coin-operated arcade games, it is not the only factor in determining success—anything with enough color, sound, and action will attract an adequate following. However, personality is a greater factor in microcomputer-based arcade games because they have fewer distracting frills. Of the many games I've seen in the past six months, Apple Panic has far more personality than any of several equally well-done games for the Apple II or II Plus microcomputers. Additionally, Apple Panic is an original game. It is not just a simplified copy of a coin-operated game. As a game that's available *only* for microcomputers, you can show it off to coin-op game snobs.

Like many successful arcade games, Apple Panic has a simple but eccentric premise. Your player is trapped in a world of walkways and ladders. The objective is to keep your player alive as long as possible. Of course, no arcade game is complete without a merciless enemy, and Apple Panic is no exception. Your enemies are a number of flattened "apples" (similar to Terrapin Turtle robots) that roam the walkways and ladders. They aren't terribly bright, but what they lack in intelligence they make up for in number. How do you fight back? By digging a hole in the walkway, waiting until an apple drops into it, and then knocking it through the hole to smash on the walkway below.

Photo 1: *An "apple" is knocked through a hole by the human player.*

You control your player's movement by using the "I," "J," "K," and "M" keys. To dig a hole, hit the "A" key while your player is moving. (For some reason, your player does not always dig a hole when you want it to. Although this is probably the result of simplifying the game's algorithm to a manageable size, I look on it as a chance to develop my expertise in the game.)

Once an apple falls into the hole and sticks there, you have several seconds to return to that hole and knock the apple through by hitting the "S" key; if you line up two or more holes well enough for the apple to drop through all of them,

you get bonus points that increase with each extra hole used. When an apple falls through a hole, the walkway is mysteriously repaired; see photos 1a and 1b. (You didn't expect this to be easy, did you?) In addition, if you don't get to a stuck apple in time, the dumb but industrious critter pulls itself out of the hole and repairs the walkway.

Although the apples are slow, they don't waste any opportunities. If they get close enough, they pounce on and eat your player. The screen is then redrawn with a different arrangement of ladders and apples, and you start over. On successive screens, you usually get more apples on the screen. If you get good enough, two new predators, the Green Butterfly and the Mask of Death, appear; the latter appears only if you are *very* good. You get more points for killing them, but they are more difficult to kill. The Butterfly must drop through two holes before it is eliminated; if it drops from one hole to the walkway immediately below, it continues walking as if nothing had happened. (You get an extra player life when you kill a Butterfly.) The Mask of Death is even more difficult to kill; it must fall through *three* holes before it is destroyed.

One final note on the mechanics of the game: your player can fall through a hole without injury. This is sometimes useful as an escape route because the apples can't follow.

At a Glance

Name
Apple Panic

Type
Arcade-style game

Manufacturer
Broderbund Software
2 Vista Wood Way
San Rafael, CA 94901

Price
$29.95

Author
Ben Serki

Format
5¼-inch floppy disk

Language
6502 machine code

Computer
Apple II or II Plus with one disk drive (13 or 16 sectors) and 48K bytes of memory

Documentation
One-page instruction leaflet

Audience
Arcade enthusiasts of all ages

Strategy

Timing is very important in this game. It takes a certain amount of time to dig a hole or knock an apple through a hole. If you underestimate the amount of time needed when an apple is nearby, it may get you before you get it.

Another element of your strategy is the placement of holes with respect to ladders. On one hand, you like to have a hole between you and every apple. On the other hand, if an apple falls into a hole on the other side of the screen, those same holes may prevent you from getting to the trapped apple in time. After hastily digging a hole, you may find that it is now impossible to get to an entire section of the screen. Also, the strategy of going to the end of a walkway, digging a hole between you and the center of the screen, and waiting for an apple to come after you usually doesn't work—the apples aren't smart enough to sense you unless you are nearby.

Conclusions

Apple Panic is an interesting, playful game. It is interesting to note that, like Pac-Man (a game similar in spirit), it uses engulfment as the main form of destruction. This is very different from the majority of games, which have objects shooting projectiles at each other.

Apple Panic makes good use of both graphics and sound. When walking, the player does not flicker (as it would with less skillful animation). Nearly constant sound effects keep the ear *entertained* without assaulting it.

Even when played by a novice, this game usually lasts longer than most other arcade-style games. Although the apples will eventually overwhelm you, split-second reflexes are not as important here as they are in other games. A normal game of Apple Panic lasts from five to fifteen minutes; it lasts longer as you get better. Therefore, while still being entertaining and engaging, Apple Panic will not leave you a nervous wreck when the game is over. (Well, less of one, anyway.)

I do have a criticism, however. This game does not have the features that allow you to indefinitely pause while you turn the sound effects off. Granted, one game can't have everything, but these easily implemented features are becoming more common on Apple games. Game designers should take note.

Apple Panic is a copy-protected disk that boots directly on either 13- or 16-sector Apple computers. Broderbund Software pledges to replace the disk free of charge if it fails to boot and to replace it for a minimal charge if the disk is ever physically damaged. This is another policy that should be encouraged. It takes away many of the objections about copy-protected disks for programs of this nature.

It should be reemphasized that Apple Panic is an original game, not a copy of an arcade game. If the current trend away from microcomputer games adapted from coin-operated arcade games continues, the work of authors and companies that produce high-quality original games will become more important.■



Missile Command

Stanley J. Wszola
Technical Editor

As your left thumb stabs at the firing button, your right hand spasmodically tries to control the cursor. You see flashes of light, hear bursts of sound, and finally it's over. You've done it, racked up your best score ever playing Missile Command. Have you ever wondered why Missile Command is such a popular game? Despite the claims of Atari that its development was a long process, there are other reasons for its success. In this review, I'd like to touch lightly upon some of these reasons.

If you have never pumped a quarter into a video arcade game, or don't own an Atari 400 or 800 microcomputer, I'll briefly describe the game. The Missile Command game for the Atari 400 and 800 is an adaptation of the commercial arcade game. You become the commander of a missile base with armaments consisting of ABMs (antiballistic missiles). You must preserve your six cities and missile base from nuclear attack by destroying the incoming enemy missiles and bombs.

The enemy is armed with ICBMs (intercontinental ballistic missiles), MIRVs (multiple independently targeted reentry vehicle ICBMs), killer

At a Glance

Name
Missile Command

Type
Arcade-type game

Manufacturer
Atari Inc.
1265 Borregas Ave.
Sunnyvale, CA 94086
(408) 745-2213

Price
$39.95

Format
Plug-in ROM cartridge

Language
6502 machine language

Computer
Atari 400 or 800 with 8K bytes of RAM and joysticks

Documentation
18-page booklet

Audience
Any Atari computer owner who enjoys a good game

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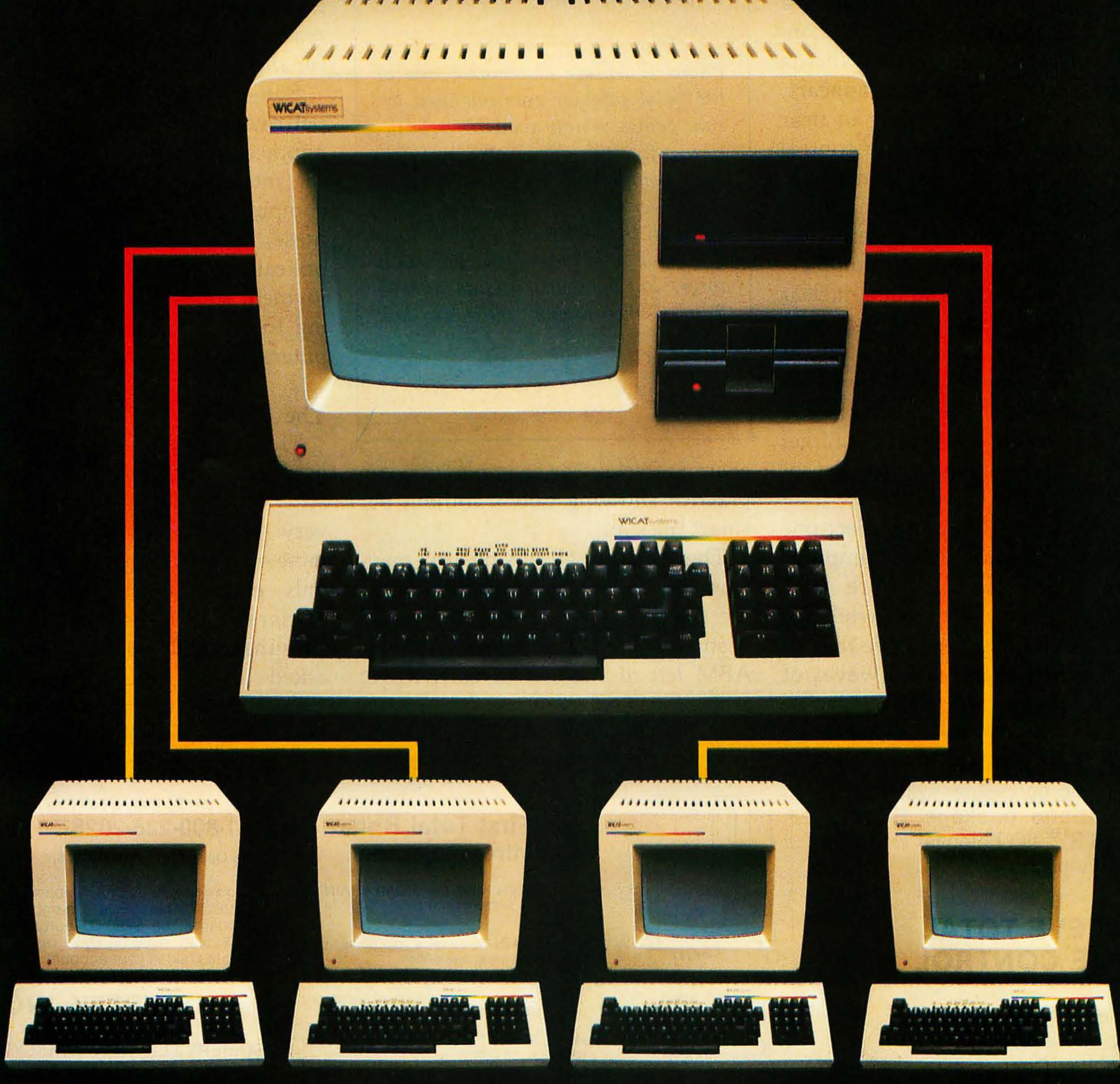
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satellites that drop missiles, bombers, and smart missiles that can evade your ABMs and home in on their targets.

The enemy attacks come in waves. Each wave lasts from 30 to 45 seconds. The waves become increasingly more difficult as the game progresses, with the sixth wave introducing you to the smart missiles.

You are provided with 30 ABMs per wave. These are launched against targets by using the joystick to control a cursor on the screen. When a missile, bomber, or satellite appears, you position the cursor over or near the target and press the fire control button. Your missile base launches an ABM toward a detonation mark left by the cursor on the screen. The resulting atomic fireball, complete with the simulated sound of a nuclear explosion, will destroy the incoming missile or other target. That is, if your aim was true, if you allowed for a moving target, if you hadn't already used all your ABMs, and if the target wasn't smart enough to get out of your way (smart missiles).

The game allows you to select one or two players. The computer automatically keeps score and remembers the highest score while the game is continuing. You have the option of skipping the easier waves of enemy attacks. For example, you can practice shooting down nothing but smart missiles.

Photo 1: *Missile Command, one of the most popular coin-operated arcade games, is now available in a cartridge for the Atari 400 and 800 microcomputers. The trackball of the coin-operated version has been replaced by an Atari joystick. Also, you have only one missile base (not three), but the sights, sounds, and action of the original game are still there.*

The object of all this nuclear mayhem is to accumulate points. Points are scored for every enemy weapon destroyed and for every city and ABM left at the end of each wave. Every two waves, a wave point multiplier increases the value of each point by as much as six times. Every time you earn 10,000 points, you get another city to replace one that was previously vaporized.

Why Is It Successful?

Though none of the editors on the BYTE staff advocate nuclear war, we all agree that Missile Command is a good game. Yet we agree for different reasons, and therein lies the reason for the game's success.

Some people enjoy the competitiveness of trying to better another person's score. Others enjoy the interaction between human and computer. And some enjoy the lights, noise, and the satisfaction of symbolically blowing things up. My enjoyment stems mostly from not having to pump quarters into the computer.

The Critics

There are those who object to the overt violence implicit in the game. After all, the destruction of cities is a very violent activity. A friend of mine once said that games of this type only encourage the acceptance of warfare as a viable solution to problems that could be settled peaceably. I asked if he ever played chess.

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When he said yes, I then asked if he thought his aggressive activities on the chessboard affected his actions in real life. A very spirited discussion then ensued, with neither of us convincing the other to change his views.

Whether the designers of Missile Command intended to or not, they have presented a game that reflects contemporary society. The game takes the threat of nuclear warfare and, simplifying the concept to the extreme, reduces that threat to a manageable human level. Whether this familiarity with nuclear warfare is good or not, I don't know. However, it doesn't seem to have affected the popularity of the game.

Conclusion

Missile Command is a great success, and Atari should be congratulated on producing such a high-quality product. However, it is only a temporary success. Programmers are constantly working on newer, better games. My advice to them is to carefully examine the current successes and determine why they work. Then, taking their own original games, incorporate those ideas in their own programs.

With the advent of new microcomputers and with the foundations for software development already well established, the potential for creative programming is greater than ever. I am excitedly awaiting what's coming next.■

Dino Wars

George Stewart
Technical Editor

If any computer game deserves the title "action game," this one does. Dino Wars is a two-player game in which each player controls a ferocious dinosaur that attempts to bite the other player's dinosaur until it cries uncle. Although there is no gore and the losing dinosaur always survives, the combat between the two creatures seems vicious at times.

The battle takes place on a desert plain decorated with several clumps of cactus. However, this is not your ordinary cactus. If a dinosaur mistakenly runs into one, the creature falls over and loses five units of fighting energy. Perhaps it's fossilized.

Although the terrain is much larger than the field of view displayed on the screen, it is not infinite. If a dinosaur exits to either the left or the right, it eventually reemerges on the opposite side of the screen. Even if not visible on the screen, battles can rage in full force and dinosaurs can trip over unseen cacti.

The dinosaurs are chunky creatures (low-resolution is the term used outside of the prehistoric epoch) modeled after *Tyrannosaurus rex*. One is purple, the other blue. (An alternate color set is available for variety.) Although not the most graceful of animals, they can swing their tails menacingly, open their jaws to bite, and swagger around the screen in any direction.

The game is three-dimensional. As a dinosaur recedes into the background, it becomes smaller, eventually shrinking to the size of a dot. As it advances, its size increases to a stage where it consumes much of the screen.

Joysticks are used to control the combatants. Although these joysticks permit 360 degrees of apparent control, the dinosaurs can actually move in only six directions. As a result, they appear to hop from one stance to another.

The object of the game is to bite the

At a Glance

Name
Dino Wars

Type
Animated dinosaur combat game

Manufacturer
Radio Shack
1800 One Tandy Center
Fort Worth, TX 76102

Price
$39.95

Author
Robert Kilgus

Format
Plug-in ROM cartridge

Computer
TRS-80 Color Computer with two joystick controllers; 16K bytes of RAM recommended for best results

Audience
Game fans age 6 and up

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other dinosaur while it is vulnerable, i.e., while it has its back turned or is recovering from a nasty fall over a cactus (the Marquis of Queensberry rules don't apply in this primitive world). After sustaining an effective bite, a dinosaur falls to the ground with a resounding crash.

When two experienced players control the dinosaurs, the battle resembles an awkward ballet, with the dinosaurs constantly circling each other while vying for a shot at each other's weak point. When beginners play, the action is more likely to resemble a pastoral scene in which the two dinosaurs wander around aimlessly, occasionally engaging one another with little effect and separating again.

To make a dinosaur bite, you press the joystick button. The dinosaur issues an awesome roar as it closes its jaws on air, cactus, or the opposing dinosaur. Generating this sound is one of the more satisfying aspects of the game.

Both dinosaurs start out with 100 units of energy. Each time a dinosaur is successfully bitten in a clinch, it loses 20 points; if bitten while recovering from a cactus fall, 10 points; falling over a cactus costs five points. The game ends when one of the dinosaurs loses all its points.

A prerequisite to enjoying this game at length is a sense of the ridiculous. Without that, you are apt to become frustrated by some of its limitations. For example, while either dinosaur is roaring, all action on the screen halts because the Color Computer's microprocessor is totally preoccupied with the task of generating the sound (a hardware limitation).

Here are bite-by-bite reports from two noteworthy dino wars.

In the first battle, one player was an expert, the other a beginner. This quite typical case corresponds to computer owner and friend. The expert player used a sneak-attack strategy: his dinosaur stayed just offscreen until the beginner's dinosaur presented a vulnerable back. Then the expert's dinosaur lunged into view, bit effectively, and retreated again. Five such attacks were enough to send the beginner's dinosaur into squeaking submission (a defeated dinosaur always runs off yelping toward the horizon).

In the second battle, two jaded players searched for a nonviolent use of the game. The cactus provided an answer. A dinosaur can become hopelessly entangled in a cactus; each time it gets up, it immediately falls down again, losing five points each time. Accordingly, the object of this absurd battle was to be the first to expend all one's energy in mortal combat with a cactus.

Dino Wars is primarily a novelty, but a good one. It allows two players to work off all sorts of aggressions toward each other and plant life. However, it is not a game you can grow with; it doesn't take long to "peak out." It is not an intellectual game like Adventure, nor does it get your adrenaline going as does a fast-paced game of Star Raiders. Compared to one of these, you might say Dino Wars is *prehistoric*. ■

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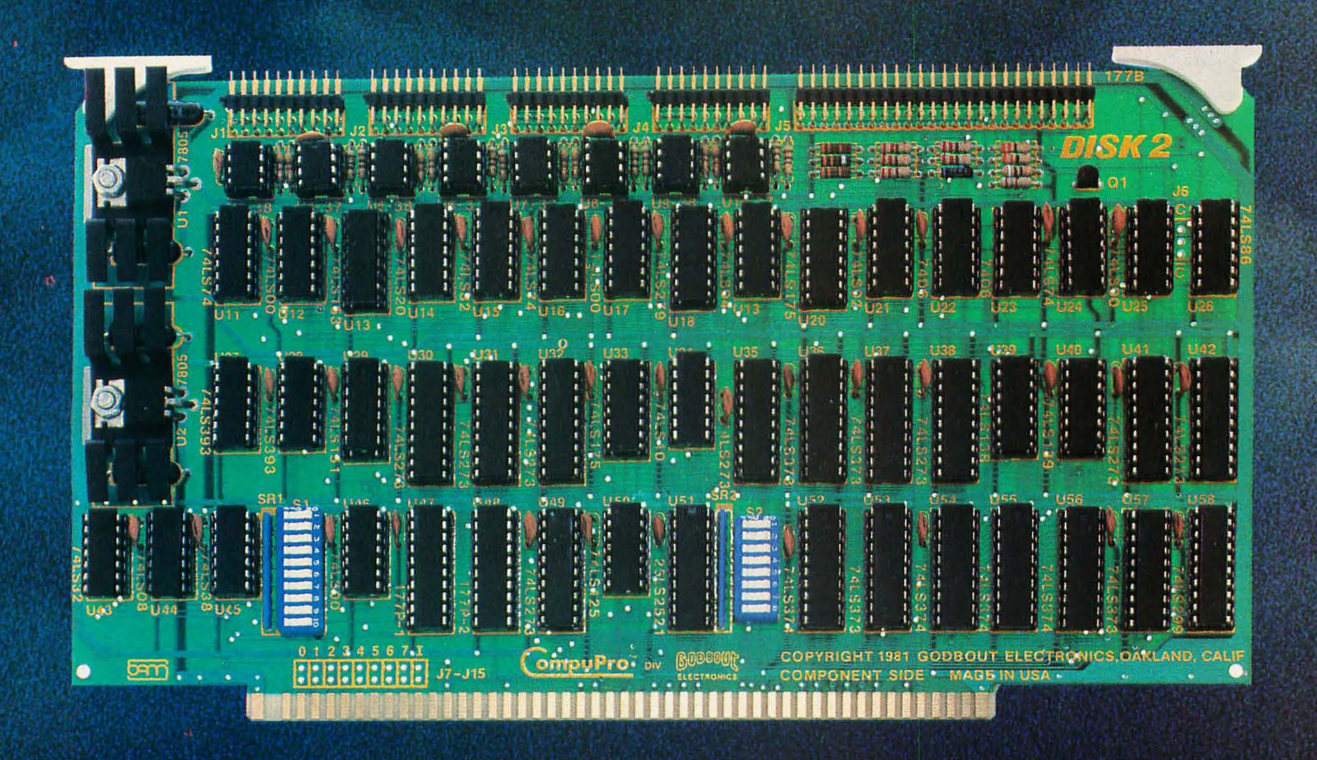
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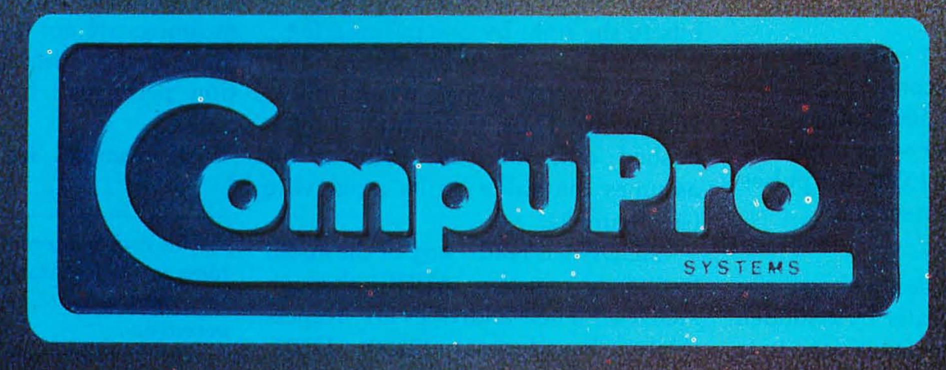


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The Atari Tutorial

Part 7: Sound

Bob Fraser
1639 Martin Ave.
Sunnyvale, CA 94087

The Atari 400 and 800 home computers have extensive hardware sound capabilities. Four independently controllable sound channels are able to play simultaneously. Each channel has a frequency register determining the note and a control register regulating the volume and the noise content. Several options allow you to insert high-pass filters, choose clock bases, set alternate modes of operation, and modify polynomial counters. This article will explain these options; next month, part 8 will show how to call these options from both BASIC and 6502 machine language.

Definitions

For the purposes of this discussion, a few terms and conventions need to be clarified:

1 Hz (hertz)	is 1 pulse per second
1 kHz (kilohertz)	is 1000 pulses per second
1 MHz (megahertz)	is 1,000,000 pulses per second

A *pulse* is a sudden voltage rise followed somewhat later by a sudden voltage drop. If a pulse is sent to a television speaker, it will be heard as a single pop.

A *wave,* as used here, is a continuous series of pulses. Different types of waves exist, each of which is distinguished by the shape of the individual pulses. Waves created by the Atari computer are square. Brass instruments typically produce triangular waves, and a human voice produces sine waves.

The smaller poly counters repeat often enough to create droning sounds that rise and fall quickly.

A *shift register* is like a memory location (in that it holds binary data) that, when so instructed, shifts all its bits to the right by one position (i.e., bit 5 will get whatever was in bit 4, bit 4 will get whatever was in bit 3, and so on). Thus, the rightmost bit is pushed out, and the leftmost bit assumes the value on its input wire (see figure 1).

"AUDF*n*" is read "any of the audio frequency registers, AUDF1 through AUDF4." Their addresses are, respectively, hexadecimal D200, D202, D204, and D206 (decimal 53760, 53762, 53764, and 53766).

"AUDC*n*" is read "any of the audio control registers, AUDC1 through AUDC4." Their addresses are, respectively, hexadecimal D201, D203, D205, and D207 (decimal 53761, 53763, 53765, and 53767).

For the purposes of this discussion, *frequency* is a measure of the number of pulses in a given amount of time; that is, a note with a frequency of 100 Hz means that in one second exactly 100 pulses will occur. The more frequent (hence, "frequency") the pulses of a note, the higher the note. For example, a singer vocalizes at a high frequency (5 kHz), and a cow moos at a low frequency (100 Hz). The words "frequency," "note," "tone," and "pitch" are used interchangeably.

Noise and *distortion* are also used interchangeably, although their meanings are not the same. Noise is a more accurate description of the function performed by the Atari computer.

All examples are in BASIC unless

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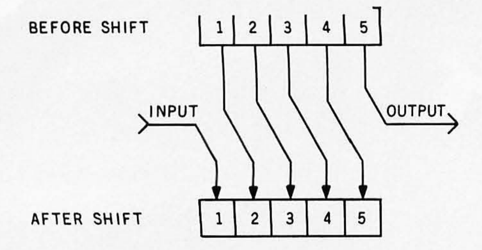


Figure 1: *Operation of a shift register. Here, all bits are shifted one bit to the right. As the rightmost bit is lost, some external value fills the leftmost bit.*

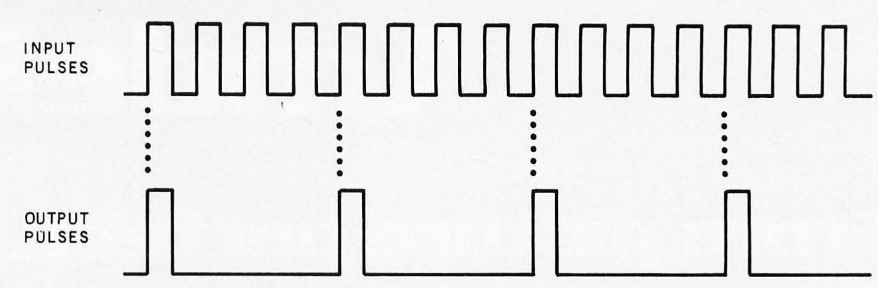


Figure 2: *An example of a divide-by-4 process. The circuitry for this process allows only every fourth pulse to pass through.*

otherwise stated. Type the examples *exactly as they appear*. If there are no line numbers, don't use any; if several statements are on the same line, type them as such.

Sound Hardware

Sound is generated in the Atari computer by the POKEY chip, a custom integrated circuit designed especially for the Atari 400 and 800; POKEY also handles the serial I/O bus and the keyboard. The POKEY chip must be initialized before it will work properly. Initialization is required after any serial bus operation (cassette, disk drive, printer, or RS-232C read/write). To initialize POKEY in BASIC, execute a null sound statement; that is, SOUND 0,0,0,0. In machine language, store a 0 at AUDCTL (hexadecimal D208 = decimal 53768) and a 3 at hexadecimal 232 (decimal 562); this is the shadow location for the SKCTL register at hexadecimal D20F (decimal 53775).

The Audio Frequency Registers

Each of the four audio channels has a corresponding frequency register that controls the note played by the computer. The frequency register contains the number *N* used in a divide-by-*N* circuit. This is not a division in the mathematical sense, but something much simpler: for every *N* pulses coming in, one pulse goes out. For example, figure 2 shows a divide-by-4 function.

As *N* gets larger, output pulses become less frequent, making a lower frequency note.

The Audio Control Registers

Each channel also has a corresponding control register. These registers allow the volume and distortion content of each channel to be set. The bit assignment for AUDC*n* is given in table 1.

Volume

The volume control for each audio channel is straightforward. The lower 4 bits of the audio-control register (AUDC*n*) contain a 4-bit number that specifies the volume of the sound. A zero in these bits means zero volume; a fifteen means as loud as possible. The sum of the volumes of the four channels should not exceed thirty-two because this forces overmodulation of the audio output. The sound produced tends to actually lose volume and assume a buzzing quality.

Distortion

Table 1 also shows that each channel has three distortion-control bits in its audio-control register. Distortion is used to create special sound effects any time a pure tone is undesirable.

The computer's use of distortion offers great versatility and control. It is easy to synthesize an almost endless variety of sounds, from rumbles, rattles, and squawks to clicks, whispers, and mood-setting background tempos.

Distortion, as used here, is not equivalent to the standard interpretation. For example, *intermodulation distortion* and *harmonic distortion* are quality criteria specified for high-fidelity stereo systems. These types of distortion refer to waveform degeneration, where the shape of the wave is slightly changed due to error in the electronic circuitry. The computer's distortion does not alter waves (they are always square), but rather deletes selected pulses from the waveform. This technique is not adequately characterized by the word "distortion." A more descriptive and appropriate term for these distortion methods is "noise."

Before you can fully grasp what we

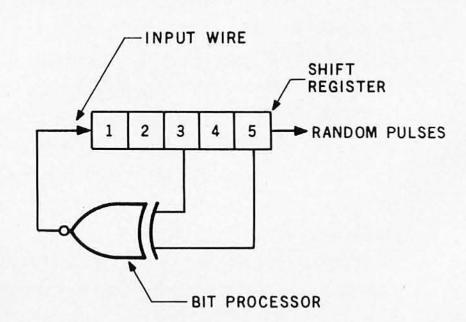
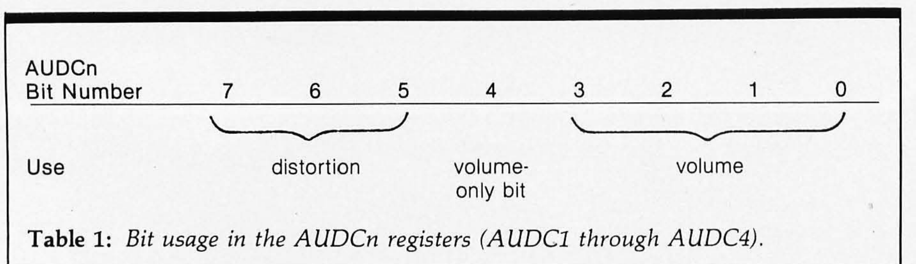


Figure 3: *An example of a poly counter. By letting the new leftmost bit be determined by some algorithm (here, an exclusive NOR of bits 3 and 5), a poly counter can produce a semirandom stream of bits. The pattern of the bits will eventually repeat, but the length of the pattern depends on the width in bits of the poly counter.*



AUDCn Bit Number	7	6	5	4	3	2	1	0
Use		distortion		volume-only bit		volume		

Table 1: *Bit usage in the AUDCn registers (AUDC1 through AUDC4).*

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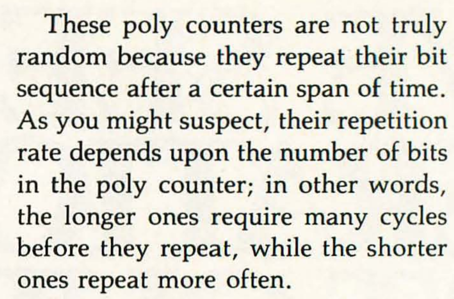
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mean by distortion, you must understand *polynomial counters* (also called *poly counters*). Poly counters are employed in the Atari computer as a source of random pulses used in noise generation. The Atari computer's poly counters utilize a shift register working at 1.79 MHz. The shift register's contents are shuffled and fed back into the input; this produces a semirandom sequence of bits at the output of the shift register.

For example, in figure 3, the old value of bit 5 will be pushed out of the shift register to become the next output pulse, and bit 1 will become a function of bits 3 and 5.

The bit processor gets values from certain bits in the shift register (in figure 3, bits 3 and 5) and processes them in a way irrelevant to this discussion. It yields a value that becomes bit 1 of the poly counter's shift register.



These poly counters are not truly random because they repeat their bit sequence after a certain span of time. As you might suspect, their repetition rate depends upon the number of bits in the poly counter; in other words, the longer ones require many cycles before they repeat, while the shorter ones repeat more often.

On the Atari computer, distortion is achieved by using random pulses from these poly counters in a *selection circuit*. This circuit is actually a digital comparator, but the term "selection circuit" is more descriptive. The only pulses making it through the selection circuit to the output are those coinciding with a random pulse. Various pulses from the input are thereby eliminated in a random fashion. Figure 4 illustrates this selection method. A dotted line connects pulses that coincide.

The net effect is this: some pulses from the frequency-divider circuit are deleted. Obviously, if some of the pulses are deleted, the note will sound different. This is how distortion is in-

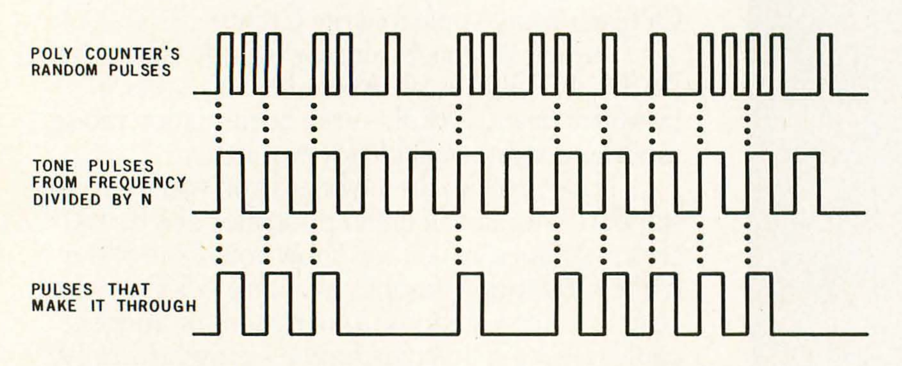


Figure 4: *Using the output of a poly counter to create a noisy tone. The resulting sound of the output pulse train is considerably modified by using the poly counter output to select pulses from a pure square-wave input.*

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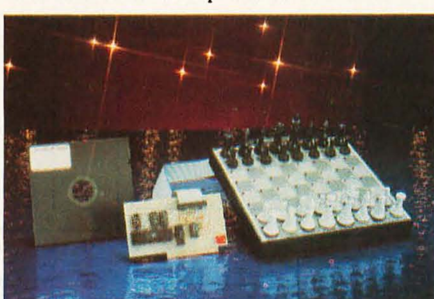
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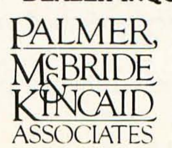
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troduced into a sound channel.

Because poly counters repeat their bit sequences, their output pattern of pulses is cyclic. And since the selection circuit uses this output pattern to delete pulses from the original note, the distorted note will contain the same repetitious pattern. This allows the hardware to create noises such as drones, motors, and other sounds having repetitive patterns.

The Atari computer is equipped with three poly counters of different lengths, which can be combined in many ways to produce interesting sound effects. The smaller poly counters (4 and 5 bits long) repeat often enough to create droning sounds that rise and fall quickly; the larger poly counter (17 bits long) takes so long to repeat that no pattern to the distortion can be readily discerned. This 17-bit poly counter can be used to generate explosions, steam, and any sound where random crackling and popping is desired. It is even irregular enough to generate *white noise* (an audio term meaning a hissing sound).

Each audio channel offers six distinct combinations of the three poly counters, which are listed in table 2. These upper AUDC*n* bits control three switches in the audio circuit as shown in figure 5. This diagram will help you understand why table 2 is structured as it is.

Each combination of the poly counters offers a unique sound. Furthermore, the distorted sounds can sound quite different at different frequencies. For this reason, some trial and error is necessary to find a combination of distortion and frequency that produces the desired sound effect. Table 3 gives you some rough guidelines with which you can begin your experimentation.

Volume-only Sound

Bit 4 of AUDC*n* specifies the volume-only mode. When this bit is set, the volume value in AUDC*n* bits 0 through 3 is sent directly to the television speaker; it is not modulated with the frequency specified in the AUDF*n* registers.

To fully understand the use of this mode of operation, you must understand how a speaker works and what happens to the television speaker when it receives a pulse. Any speaker has a cone that moves in and out. The cone's position at any time is directly proportional to the voltage it is receiving from the computer at that time. If the voltage sent is zero, the speaker is in the resting position. Whenever the cone changes position, it moves air that is detected by your ear as sound.

From our definition of a pulse, you know that it consists of a rising voltage followed by a falling voltage.

AUDCn Bit 7	6	5	Type of Distortion Carried Out
0	0	0	Divide clock by frequency, select using 5-bit then 17-bit poly counter, then divide by 2
0	X	1	Divide clock by frequency, select using 5-bit poly counter, then divide by 2
0	1	0	Divide clock by frequency, select using 5-bit then 4-bit poly counter, then divide by 2
1	0	0	Divide clock by frequency, select using 17-bit poly counter, then divide by 2
1	X	1	Divide clock by frequency, then divide by 2 (no poly counters used)
1	1	0	Divide clock by frequency, select using 4-bit poly counter, then divide by 2

Table 2: *Types of distortion available from the Atari 400/800. See table 1 for the usage of other bits in each AUDCn register. An "X" in the second column of the table represents a bit that can be either 0 or 1.*

AUDCn Bit			Examples of Resulting Sound		
7	6	5	Low frequencies	Middle frequencies	High frequencies
0	0	0	Geiger counter	raging fire	rushing air steam
0	X	1	machine gun auto at idle	electric motor	power transformer
0	1	0	calm fire	laboring auto	auto with a "miss"
1	0	0	building crashing in	radio interference	waterfall
1	X	1	pure musical tones		
1	1	0	airplane	lawn mower	electric razor

Table 3: *Types of sounds available from the six types of distortion available from each AUDCn register. An "X" in the second column of the table represents a bit that can be either 0 or 1.*

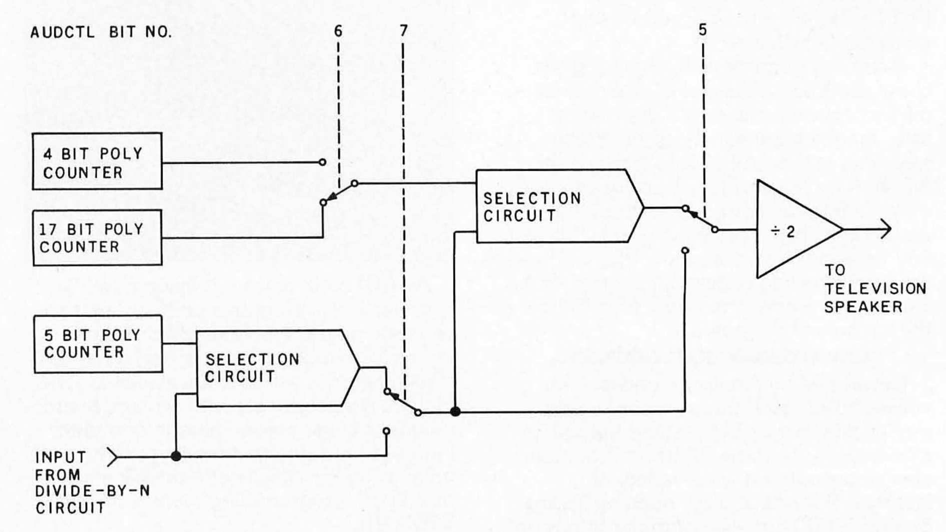


Figure 5: *A schematic representation of the effects of bits 5 through 7 of the AUDCTL register on the sound sent to the television speaker.*

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If you sent the speaker a pulse, it would push out with the rising voltage and pull back with the falling voltage, resulting in a wave of air that can be detected by your ear as a pop. The following statements produce such a pop on the television speaker by sending a single pulse:

```
POKE 53761,31:POKE 53761,16
```

A stream of pulses (or wave) would set the speaker into constant motion, and a continuous buzz or note would be heard. The faster the pulses are sent, the higher the note. This is how the computer generates sound on the television speaker.

It is essential to note that in the volume-only mode the volume sent does not drop back to zero automatically, but remains constant until the program changes it. The program should modulate the volume often enough to create a noise. Now try the following two statements, listening carefully after each:

```
POKE 53761,31
POKE 53761,31
```

The first time you heard a pop, as expected. The speaker pushed out and moved air. But the second time you didn't because the speaker cone was already in the extended position; an identical extension command did nothing to the speaker. Since it moved no air, you heard nothing. Now try this:

```
POKE 53761,16
POKE 53761,16
```

As before, you heard a pop the first time as the speaker moved back to its resting position, and you heard nothing the second time because the speaker was already in the resting position.

Thus, the volume-only bit gives the program complete control over the position of the speaker at any time. Although the examples given above are only binary examples (either on or off), you are by no means limited to this type of speaker modulation. You can set the speaker to any of 16 distinct positions.

For example, a simple triangle wave (similar to the waveform produced by brass instruments) could be generated by sending a volume of 8 followed by 9, 10, 11, 10, 9, 8, 7, 6, 5, 6, 7, and back to 8, then repeating this sequence over and over very rapidly. By changing the volume quickly enough, virtually any waveform can be created. It is feasible, for example, to perform voice synthesis using this technique. However, this requires the use of assembly language. There is more discussion of this bit in part 8 of this series.

AUDCTL

In addition to the independent channel-control bytes (AUDC*n*), an option byte (AUDCTL) affects all four channels. Each bit in AUDCTL is assigned a specific function, as shown in table 4. AUDCTL is at location D208 hexadecimal, 53768 decimal.

Clocking

Before proceeding with the explanations of the AUDCTL options, a

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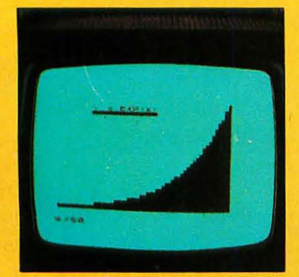
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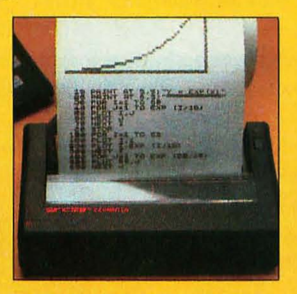
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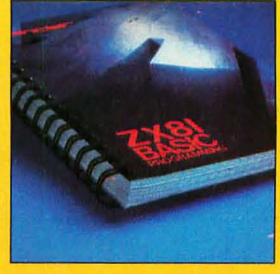
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AUDCTL Bit	Function Performed If Bit Set
0	Switches the main clock base from 64 kHz to 15 kHz
1	Inserts high-pass filter into channel 2, clocked by channel 4 (only frequencies higher than that of channel 4 are passed by the filter)
2	Inserts high-pass filter into channel 1, clocked by channel 3 (only frequencies higher than that of channel 3 are passed by the filter)
3	Joins channel 4 to channel 3 to give 16-bit resolution
4	Joins channel 2 to channel 1 to give 16-bit resolution
5	Clocks channel 3 with 1.79 MHz
6	Clocks channel 1 with 1.79 MHz
7	Makes the 17-bit poly counter into a 9-bit poly counter

Table 4: *Modifications to the sound-generation registers available by manipulation of the bits in register AUDCTL (location D208 hexadecimal, 53768 decimal). Bit 7 is the most significant bit in the register.*

new concept must be explained: clocking. In general, a clock is a train of pulses used to synchronize the millions of internal operations occurring every second in any computer. The central clock pulses continuously, each pulse telling the circuitry to perform another step in its operations. You may remember that a divide-by-*N* frequency divider outputs one pulse for every *N*th input pulse. You also may have wondered where the input pulses come from. One main input clock runs at 1.79 MHz; it can provide the input pulses. Also, several secondary clocks can be used as input clocks. The AUDCTL register allows you to select the clock used as the input to the divide-by-*N* circuit. If you select a different input clock, the output from the frequency divider will change drastically.

For example, imagine that you are using the 15-kHz clock, with the frequency register set to divide by 8. The rate of output pulses from the divide-by-*N* circuit would be about 2 kHz. But if you changed the selection of clocks to get the 64-kHz clock and did not change the frequency register, what would happen? The divide-by-*N* would still be putting out one pulse for every eighth input pulse, but the input rate would be 64 kHz. The result is an output frequency (from the divide-by-*N*) of 8 kHz. Thus, you can see that reclocking changes the frequency independent of the frequency register and on a larger scale.

The formula for the output frequency (from the divide-by-*N*) is quite simple:

$$\text{Output frequency} = \frac{\text{Clock}}{N}$$

Setting bit 0 of the AUDCTL register switches from the 64-kHz clock to the 15-kHz clock. Note that if this bit is set, every sound channel clocked with the 64-kHz clock will instead use the 15-kHz clock. Similarly, by setting bits 5 or 6, you can clock channels 3 or 1, respectively, with 1.79 MHz. This will produce a much higher note, as demonstrated by the following example:

```
SOUND 0,255,10,8
POKE 53768,64
```

The SOUND statement causes channel 1 to give a low tone, and the POKE sets AUDCTL bit 6 to 1, causing the pitch generated by channel 1 to jump to a much higher note.

16-Bit Frequency Options

The 8 bits of resolution in the frequency-control registers normally provide more than adequate resolution for the task of selecting any desired frequency. There are, however, situations in which 8 bits are inadequate. Consider what happens when you execute the following statements:

```
FOR I=255 TO 0 STEP -1:
SOUND 0,I,10,8:NEXT I
```

Initially, the sound rises smoothly,

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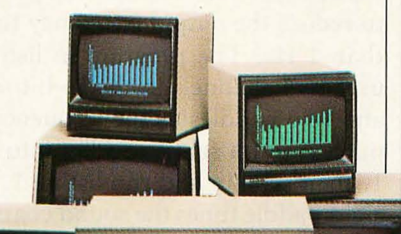
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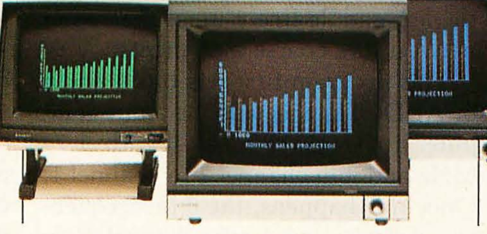


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Listing 1: *A program that uses a 16-bit divide-by-N register. When used with game paddles in port 1, this program produces a sound with a frequency that can be varied by paddles 1 and 2. Paddle 1 changes the sound in large steps; paddle 2 changes the sound between two adjacent large steps.*

```
10  SOUND 0,0,0,0,: REM                          Initialize sound
20  POKE 53768,80: REM                           Clock channel 1 with 1.79 MHz, clock
                                                 channel 2 with channel 1
30  POKE 53761,160:POKE 53763, 168: REM          Turn off channel 1, turn on channel 2
                                                 (pure tones)
40  POKE 53760,PADDLE(0):POKE 53762,PADDLE(1)
50  GOTO 40: REM                                 Set paddles to put frequencies in
                                                 frequency registers
```

but as it approaches the end of its range the frequency takes larger and larger steps that are noticeably clumsy. This happens because you are dividing the clock by smaller and smaller numbers: 15 kHz divided by 255 is almost the same as 15 kHz divided by 254; however, 15 kHz divided by 2 differs greatly from 15 kHz divided by 1. The only way to solve this problem is to use a larger number that allows you to specify frequency with greater precision. The means to do this are built into POKEY.

AUDCTL bits 3 and 4 allow two channels to be joined, creating a single channel with an extended dynamic-frequency range. Normally, each channel's frequency-divider number can range from 0 to 255 (which results from 8 bits of divide-by-*N* capability). Joining two channels allows a frequency range of 0 to 65535 (16 bits of divide-by-*N* capability). In this mode, it is possible to reduce the output frequency to less than 1 Hz. The program in listing 1 uses two channels in the 16-bit mode and two paddles as the frequency inputs. Insert a set of paddles into port 1, then type in and run listing 1. The right paddle tunes the sound coarsely; the left paddle finely tunes the sound between the coarse increments.

This program first sets bits 4 and 6 of AUDCTL; this tells the Atari computer to clock channel 1 with 1.79 MHz and join channel 2 to channel 1. Once this happens, the 8-bit frequency registers of both channels are assumed to represent a single 16-bit number *N* that is used to divide the input clock. Next, the volume of channel 1 is set to 0. Since channel 1 no longer has its own direct output, its volume setting is meaningless to us and we zero it. The channel 1 frequency register is used as the fine-tuning or low byte in the sound generation; the channel 2 frequency register is the coarse-tuning or high byte. For example, poking a 1 into the channel 1 frequency register makes the pair of registers divide by 1. Poking a 1 into the channel 2 frequency register makes the pair divide by 256. Poking a 1 into both frequency registers makes the pair divide by 257.

Bit 3 of AUDCTL can be used to join channel 4 to channel 3 in the same way.

The following instructions demonstrate some interesting aspects of 16-bit sound (try poking other numbers into the last four locations):

```
SOUND 0,0,0,0
POKE 53768,24
POKE 53761,168
POKE 53763,168
POKE 53765,168
POKE 53767,168
POKE 53760,240
POKE 53764,252
POKE 53762,28
POKE 53766,49
```

High-Pass Filters

AUDCTL bits 1 and 2 control high-pass filters in channels 2 and 1, respectively. A high-pass filter allows only higher frequencies to pass through. In the case of these high-pass filters, high frequencies are defined as anything higher than the output of another channel selected by

the AUDCTL bit combination. For example, if channel 3 is playing a cow's moo and AUDCTL bit 2 is set, only sounds with frequencies higher than the moo will be heard on channel 1 (anything lower than the "moooo" will be filtered out). See figure 6.

The filter is programmable in real time because the filtering channel can be changed on the fly. This opens a large field of possibilities to the programmer. The filters are generally used to create special effects. Try the following statements:

```
SOUND 0,0,0,0
POKE 53768,4
POKE 53761,168:POKE 53765,168
POKE 53760,254:POKE 53764,127
```

9-Bit Polynomial Conversion

Bit 7 of AUDCTL, when set, turns the 17-bit poly counter into a 9-bit poly counter. The shorter the poly counter, the more often its distortion pattern repeats, or the more discernible is the pattern in the distortion. Therefore, changing the 17-bit poly counter into a 9-bit poly counter makes the noise pattern more repetitious and more discernible. Try the following demonstration of the 9-bit poly-counter option, listening carefully when the POKE is executed:

```
SOUND 0,80,8,8
POKE 53768,128
```

The first statement activates the 17-bit poly counter; the second changes the counter to a 9-bit poly counter.

Next Month

Now that we know about the various registers that control the sound-generating capabilities of the Atari 400/800, we will look at several BASIC and machine-language techniques to use sound within a program. ■

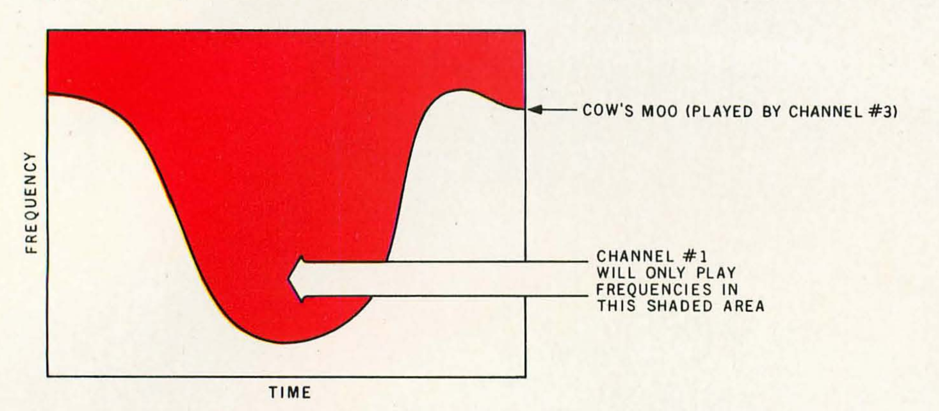
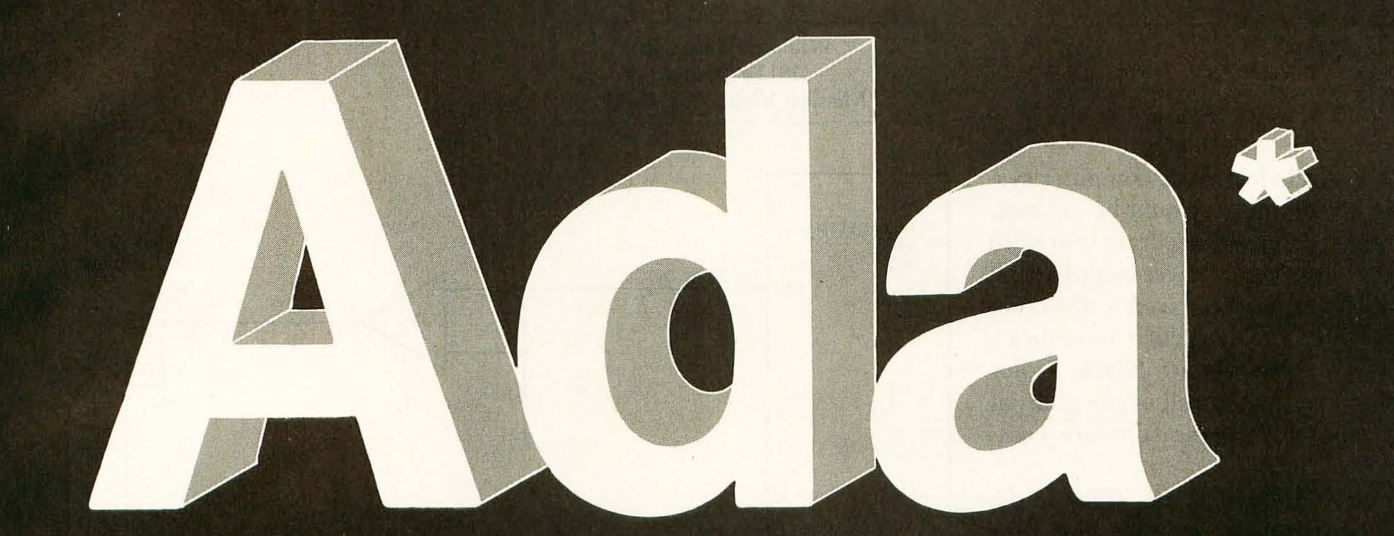


Figure 6: *High-pass filtering in the Atari 400/800. At any given instant, the only frequencies in channel 1 that are passed by the filter are those greater than the frequency being played in channel 3.*

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Build a Half-year Clock for the Color Computer

Fourth in a Series

William Barden Jr.
28122 Orsola
Mission Viejo, CA 92692

The ideal clock for a computer system, to my mind, would be an inexpensive, compact, accurate unit with a self-contained power supply that could be easily interfaced to the computer system. This article describes a clock for the Radio Shack Color Computer; it meets all of my goals at the expense of some software complexity.

The half-year clock (HYC) described here can provide the time with a resolution of ± 10 seconds or better over a six-month period. Powered by a self-contained 9-volt (V) battery, it can be disconnected from the Color Computer at any time, set aside, plugged in later, and will continue reporting the time. It is a compact unit measuring 14 by 9 by 3.8 cm (5½ by 3½ by 1½ inches).

The HYC uses seven integrated circuits (ICs) plus some discrete components. The project is built using wire-wrapping techniques. If you've never tried wire-wrapping, fear not: I'll provide detailed tips for easy construction.

Since the HYC communicates with the Color Computer via the serial interface of the computer, I'll start with a description of that interface.

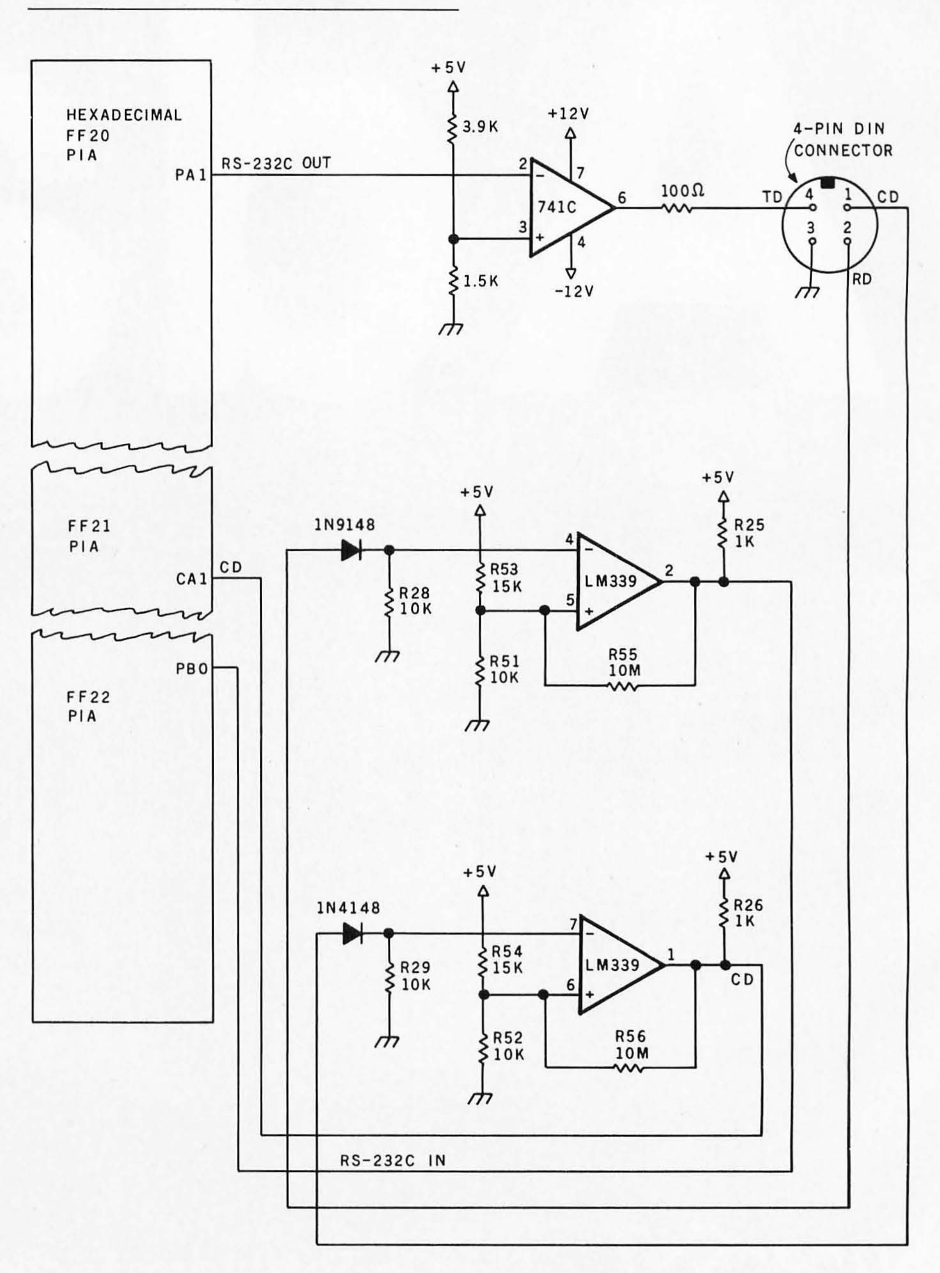


Figure 1: *The Color Computer RS-232C interface consists of two comparators and one op amp used as a comparator. The TD signal is generated from software by output to PIA (peripheral interface adapter) address FF20 hexadecimal. The RD is read into PIA address FF22 hexadecimal. The CD signal is not normally used and is an "edge trigger" signal generating a PIA interrupt.*

Color Computer Serial Interface

The complete serial interface of the Color Computer is shown in figure 1. The four lines of the serial interface go to a 4-pin DIN plug on the rear of the system. These four lines are a subset of the 25 lines normally used in other computer systems, such as the Radio Shack Models I and III. The Color Computer uses *asynchronous*

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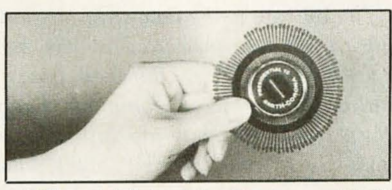
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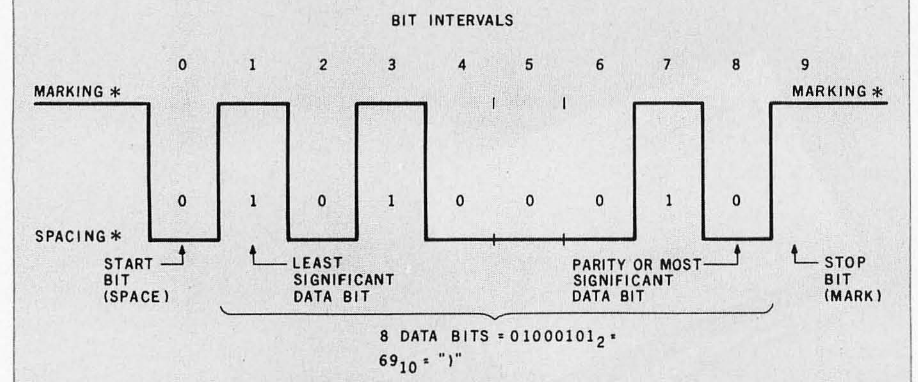
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Data sent in asynchronous RS-232C format typically consist of a start bit, 8 bits of data, and one or two stop bits. The bits are evenly spaced with no inherent clock.



Asynchronous Communication

The EIA standard RS-232C defines the format for data communication. Therefore, serial communication is often called "RS-232C" or "RS-232" communication. A system channel designed for data communication is known as a serial or RS-232 port.

The standard format for asynchronous communication is shown above. In this example, 8 bits make up the actual data word. The data are asynchronous, that is, they are sent at unpredictable times, rather than at regularly spaced intervals. A good example of an asynchronous datum is a character transmitted from a keyboard to a communications system such as The Source or Compuserve. The host system does not know when to expect the next character—it may occur within 1/10 second or 10 seconds. Each character must be detected and handled as an independent "event."

The computer system or device receiving an asynchronous character can read either a logic 1 or logic 0 on the receive data *(RD) line. Initially, the RD line is at logical 1, called "mark." The receiving system or device expects this high condition to exist initially. To signal the start of a data word, the transmitting system sends a* start bit *by bringing the RD line to a logical 0, called a "space," for a duration known as a "bit time." The length of the bit time depends on the data-transmission rate and may vary from about 9 milliseconds to 0.1 millisecond.*

The receiving system or device detects the start bit, delays ½ bit time, and gets set to receive the rest of the data word at evenly spaced intervals of one bit time. The start bit is followed by eight data bits (one of which may be a parity *bit) and one or two* stop bits *that are always at logic 1 (mark). The stop bits ensure that the RD line will be marking prior to transmission of the next data word.*

The bit rate *is the data-transmission rate of all data measured in bits per second (bps). Three hundred bps is typical for the Color Computer. Each character at this bit rate typically is made up of one start bit, eight data bits, and one stop bit, for a total of 10 bits. Thus, 300 bps yields 30 characters per second. The bit time is 1/300 second, or 3.33 milliseconds.*

The standard logic levels for RS-232C communication are voltages above 3 V (logic 0) and below −3 V (logic 1). In the Color Computer, the voltages used are 12 V for logic 0 and −12 V for logic 1.

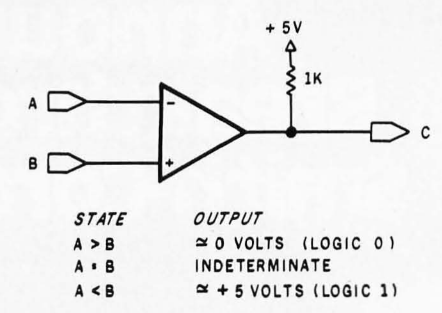


Figure 2: *A comparator contrasts two input signals in relation to each other. If the "+" (plus) input is greater than the "−" (minus) input, a logical 1 is generated at the output; if the "+" input is less than the "−" input, a logical 0 is produced.*

serial communication, which requires only three lines; the fourth line is available for special purposes. See the text box for background information on serial communication.

Interface operation. The Color Computer's serial interface is made up of one comparator (actually an operational amplifier) for controlling the transmit data (TD) line and two comparators for checking the receive data (RD) and carrier detect (CD) lines.

A comparator accepts two input voltages. If the "+" (plus) input voltage is higher than the "−" (minus) input, the comparator outputs a logic 1; if the "+" input voltage is lower than the "−" input, the comparator outputs a logic 0 (see figure 2).

In the following descriptions, I'll be referring to a few "memory" addresses in the Color Computer that function as I/O lines—part of the peripheral interface adapter (PIA).

TD line. The 741C operational amplifier compares the "−" input from bit 1 of port address FF20 hexadecimal with the "+" input from the voltage divider R23/R24. The "+" input is a constant +1.38 V. A logic 1 on port FF20 hexadecimal bit 1 will generate −12 V on the TD line; a logic 0 will generate +12 V on the TD line.

RD and CD lines. The two LM339 comparators have serial data as their input. Both have the same configuration. One is connected to the RS232IN line of port FF22 hexadecimal bit 0. The second is con-

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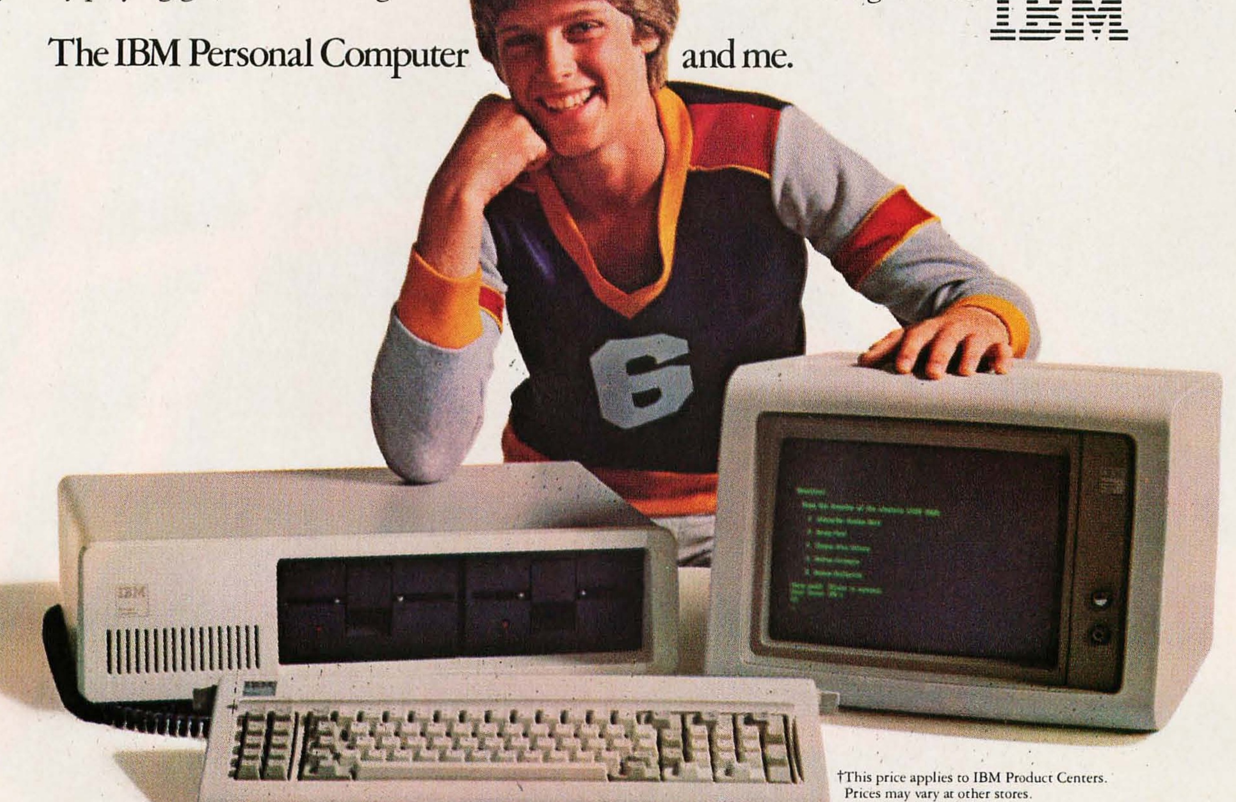
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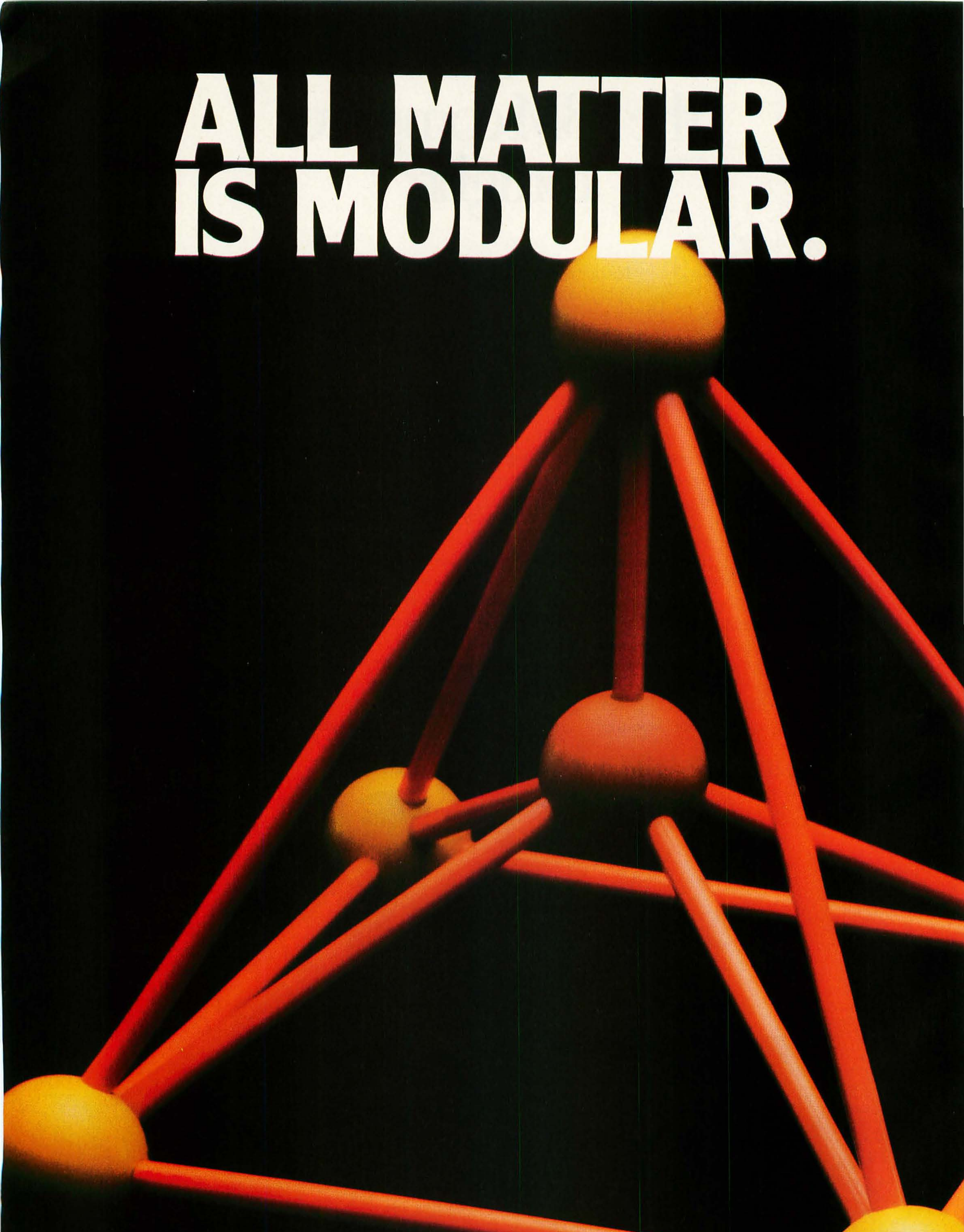
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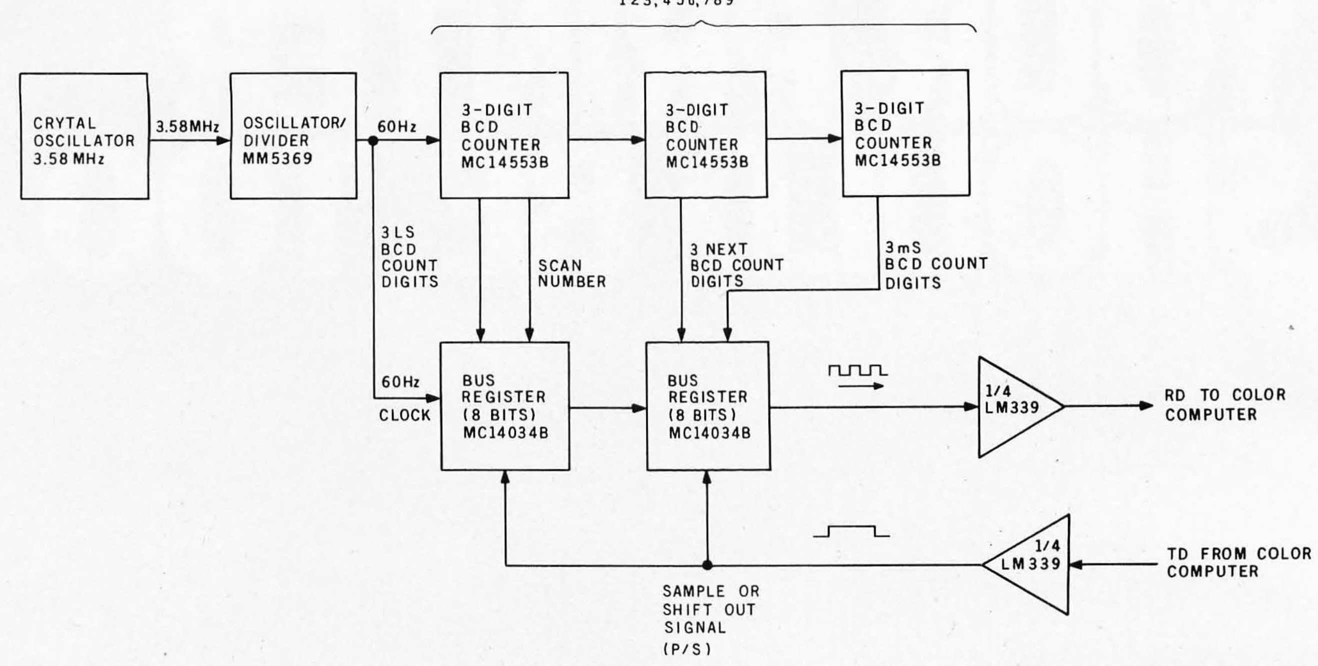


Figure 3: *The half-year clock consists of a crystal oscillator, a divider producing 60-Hz pulses, a 9-digit BCD counter, a parallel/serial register, and comparator output to the Color Computer.*

nected to the CD line of port FF21 hexadecimal. The CD line generates an interrupt and is not used in this project.

The "+" input of the RS232IN comparator is biased at +2 V by the R54/R52 voltage divider. The "−" input is connected via a diode to the RD line. If the RD line is at 2.6 V (+2-V bias plus about 0.6 V for the diode), the output of the comparator is a logic 0, or about 0 V. If the RD line is less than 2.6 V, the diode will not conduct, and the output of the comparator is a logic 1, or about +5 V. In short, the RS232IN signal follows the serial data on the RD line and can be tested by reading FF22 hexadecimal bit 0.

The third line used in serial communication is ground, which is connected to pin 3 of the DIN connector.

HYC Design

A block diagram of the HYC is shown in figure 3. It interfaces to the Color Computer via the RD, TD, and ground lines of the serial port. The clock count is sent via the RD line after a prompt by the Color Computer from the TD line.

At the heart of the HYC are three BCD (binary-coded decimal) counter chips. Each chip accumulates a three-decimal digit count of 0 to 999. Together, the three chips accumulate a count of up to 999,999,999.

The input to the three counters is a 60-hertz (Hz) signal from the oscillator/divider chip. This chip takes a 3.58-megahertz (MHz) signal from a "color burst" crystal and divides it down to 60-Hz signals.

At any given time, the count in the counter chips represents the number of 60-Hz pulses received. The maximum count of 999,999,999 represents 16,666,666 seconds—about 192 days.

The two "universal bus register" chips load 16 bits from the counters upon command from the Color Computer. The bits are then shifted out to the RD line at a rate of one every 1/60 second. It requires three transfers (48 bits total) to transmit the current time to the Color Computer. (Of course, the Color Computer has to decode it into a usable form.) The detailed logic diagram of the HYC is shown in figure 4.

Counters. The counters are Motorola MC14553B ICs. Each chip increments its count by one each time a 60-Hz pulse is received from the CLK input. To output its count, each chip presents one digit at a time over the Q3 through Q0 outputs. Q3 through Q0 represent a BCD digit of 0000 through 1001. For example, if the count in one of the MC14553B chips was "678," the outputs on Q3 through Q0 would be, in sequence, 0110, 0111, and 1000.

The chips are outputting their counts continually. The *scan rate,* the rate at which the three digits appear, is controlled by an external capacitor connected to C1A and C1B. A 1.0-microfarad (μF) capacitor generates a scan rate of about 3 Hz, or a new BCD digit every 333 milliseconds (ms). The scan frequency has no relation to the 60-Hz clock frequency. This scan frequency is applied to all three counters simultaneously so that the BCD digits of all sets of Q3 through Q0 change at the same time.

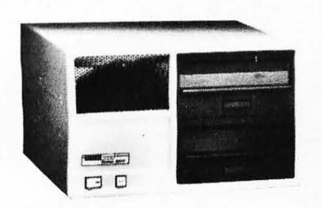
The DS3 to DS1 outputs indicate which BCD digit is being displayed on the Q3 through Q0 outputs. If DS3=0, the most significant digit is being output; if DS2=0, the next digit is being output; and if DS1=0, the least significant digit is being output.

To read the current count requires three reads of Q3 through Q0: at DS1 time, DS2 time, and DS3 time. When

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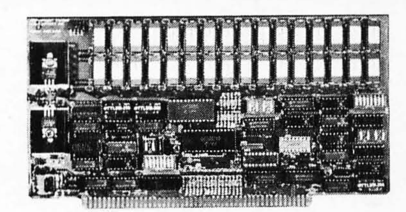
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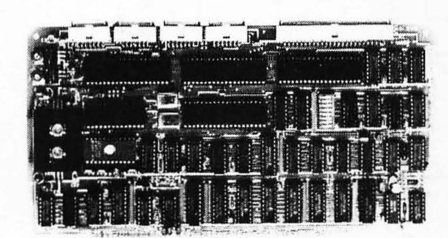
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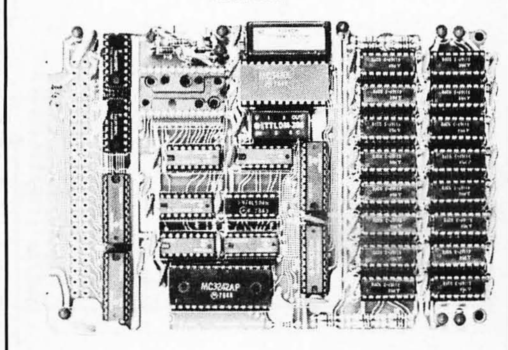
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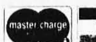
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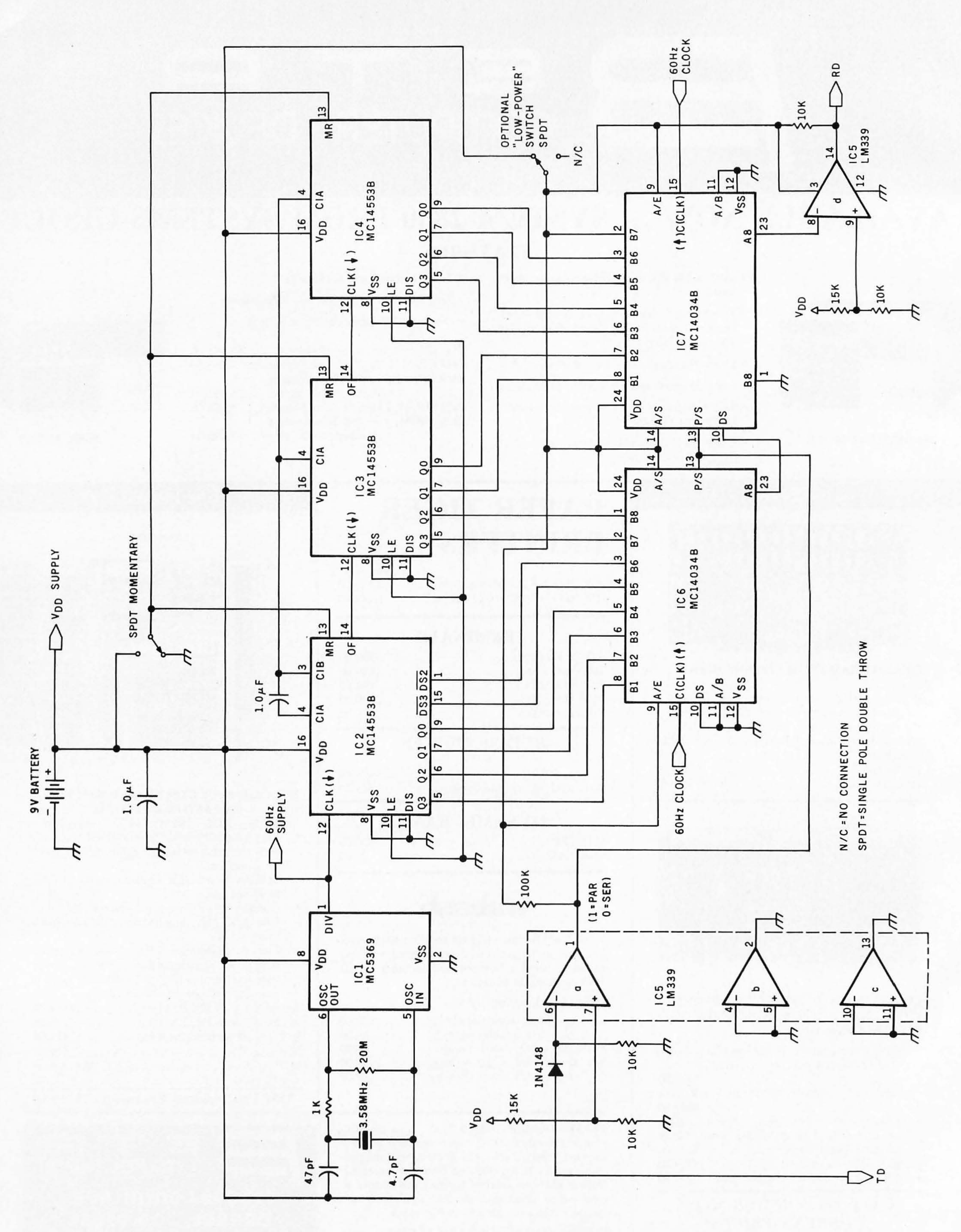


Figure 4: *The half-year clock uses seven integrated circuits, most of which are CMOS devices. The counter information is multiplexed and the count data are brought into the Color Computer in three segments of 2 bytes each.*

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the outputs are shuffled around in the proper order, the nine digits represent the current count.

The OF signal is the "carry" output to the next counter. This appears on the thousandth count when the counter recycles to 000. The disable (DIS) and latch enable (LE) lines are not used in this application configuration. MR, "master reset," is used to zero the counters when a momentary switch is pulsed.

Bus registers. The bus-register chips are Motorola MC14034B ICs. They contain two 8-bit registers and can operate in a number of different modes, depending upon the configuration of the A/E, P/S, A/B, and A/S inputs. The two modes being used here are "synchronous parallel data input" and "synchronous serial data input."

In the first mode, parallel data are strobed in by the clock input. In our circuit, 14 bits of data from the counter chips are strobed in. Twelve of these bits are the current BCD digits from each counter chip. Two of the bits are the DS3 and DS2 scan signals. (The third scan signal, DS1, is not needed, since we can infer that it is active when DS3 and DS2 are inactive.)

Setting the P/S signal to logic 1 selects the parallel data input mode. The 14 lines are continuously strobed in on the rising edge of every C (CLK) input. Since the clock runs at 60 Hz, the 14 lines are recorded 60 times per second.

When signal P/S is a logic 0, the bus registers are in the serial data input mode. This is something of a misnomer because this mode not only shifts in new data, but also shifts out previously recorded data; in this case, the 14 bits recorded earlier. The 14 "old" bits are shifted out at a 60-Hz rate. To allow synchronization of the serial bit stream, a leading 0 and 1 are prefixed to every 14-bit group.

RS-232 interface. The Color Computer's RD line is driven by the least significant bit of the HYC's lower-order bus register. The output is about 0 V if the data bit is a 1, or about +5 V if the data bit is a 0. The "bit time" of this output is 1/60 second, or about 16.66 ms. This RD output goes into the RS232IN bit of port FF22 hexadecimal.

The Color Computer's TD line drives the HYC's mode-select signal P/S. The level at the P/S pin changes from 0 V to close to +9 V for a positive or negative input, respectively. The P/S signal is logically equivalent to the status of the RS232OUT bit in port FF20 hexadecimal.

CMOS circuitry. All chips except the LM339s are CMOS (complementary metal-oxide semiconductor). CMOS is characterized by low power consumption. The HYC requires less than 4 milliamperes (mA) of current. The optional power switch shown in figure 4 lets you extend battery life when the HYC is not connected to the system or when the Color Computer is not in use. It shuts off power to all

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Integrated Circuits
IC1 Motorola MM5369 oscillator/divider
IC2-IC3 Motorola BCD counter
IC5 LM339 comparator
IC6-IC7 Motorola MC14034B universal bus register*

Resistors
1 1 KΩ, ¼ W, 10%
4 10 KΩ, ¼ W, 10%
2 15 KΩ, ¼ W, 10%
1 100 KΩ, ¼ W, 10%
1 20 MΩ (use two 10 MΩ), ¼ W, 10%

Capacitors
1 4.7-pF disk
1 47-pF disk
2 1.0-μF electrolytic, 25 V

Miscellaneous
1 3.58-MHz crystal
1 SPDT momentary switch, miniature
1 SPST or SPDT switch, miniature (optional)
1 1N4000 series diode (not critical)
1 4-pin male DIN connector*
1 9-V battery, alkaline
1 8-pin wire-wrap socket
1 14-pin wire-wrap socket
3 16-pin wire-wrap sockets
2 24-pin wire-wrap sockets*
1 prototype board
1 case
1 ribbon cable, 3- or 4-conductor wire-wrap wire, solder, #14 wire, battery connectors

Table 1: *Parts list for the half-year clock. All parts, except those starred, are available from Radio Shack.*

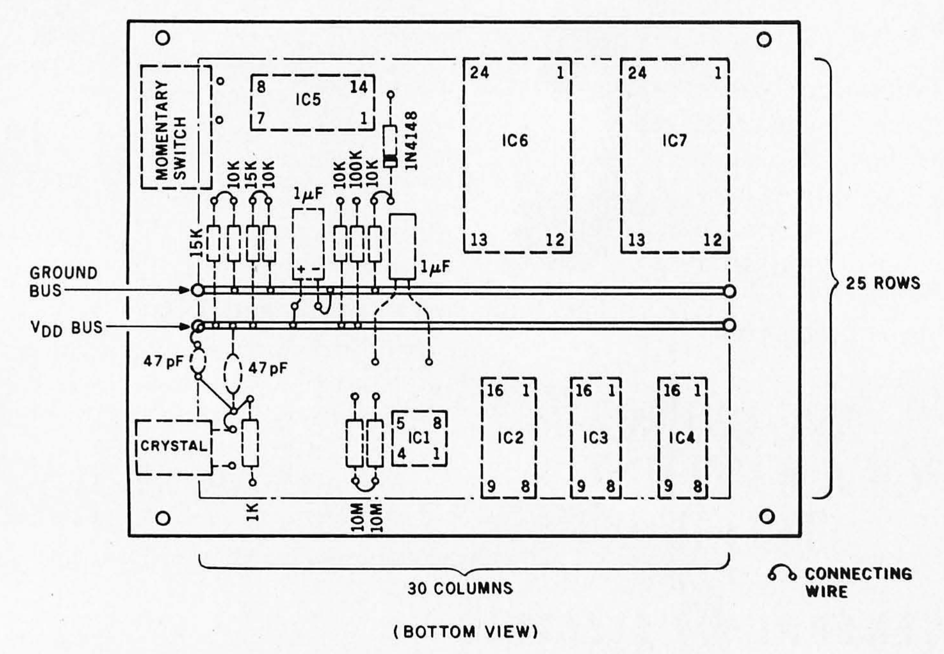


Figure 5: *A 7- by 9.5-cm (2¾- by 3¾-inch) grid board holds seven wire-wrap sockets, eighteen discrete components, and two bus lines to facilitate wiring.*

components not involved in maintaining the half-year count.

A typical alkaline battery has a capacity of about 0.5 ampere-hours, making the HYC functional for about 250 hours of continuous use in the low-power mode, or about 125 hours of continuous use without the optional power switch. This 5/10-day life can be extended by paralleling a number of 9-V batteries or by using a larger battery, such as the NEDA 1603 size, which will not fit in the case used here, but which will last a good deal longer—over 1000 hours in the low-power mode.

CMOS operates on a power supply of from 3 to 18 V. The voltage of the supply can be degraded quite far before the HYC will stop operating. The limiting factor is the RD output, which must swing from 0 to at least +2.6 V for proper comparator operation in the Color Computer.

Construction of the HYC

All the parts in the HYC are easy to obtain. The 3.58-MHz crystal, oscillator/divider, counter chips, and LM339 are stocked by Radio Shack. The bus-register chips are available from any well-stocked parts supplier (see the ads in any issue of BYTE). The cost of all parts should be under $20. See the parts list in table 1.

The HYC is housed in a project case (Radio Shack 270-219 or equivalent). This plastic case has a built-in compartment large enough to hold a 9-V battery.

A 7- by 9.5-cm (2¾- by 3¾-inch) grid board is used to hold the components. Two #14 bus wires run down the center of the board. One is used for the V_{DD} bus (+9 V); the other is ground (see figure 5).

The board has printed-circuit pads on one side. Mount the IC sockets, resistors, capacitors, and crystal on the side of the board without the foil. Solder two diagonally opposing pins of the IC sockets. Leave the resistor, capacitor, and crystal leads uncut for wire-wrapping.

Wire-wrap the IC pins according to table 2. All detailed connections are shown, but obvious power-supply connections are not indicated. I

recommend buying precut wire in lengths of 1, 2, and 3 inches. It is inexpensive and will cut the wire-wrap time in half.

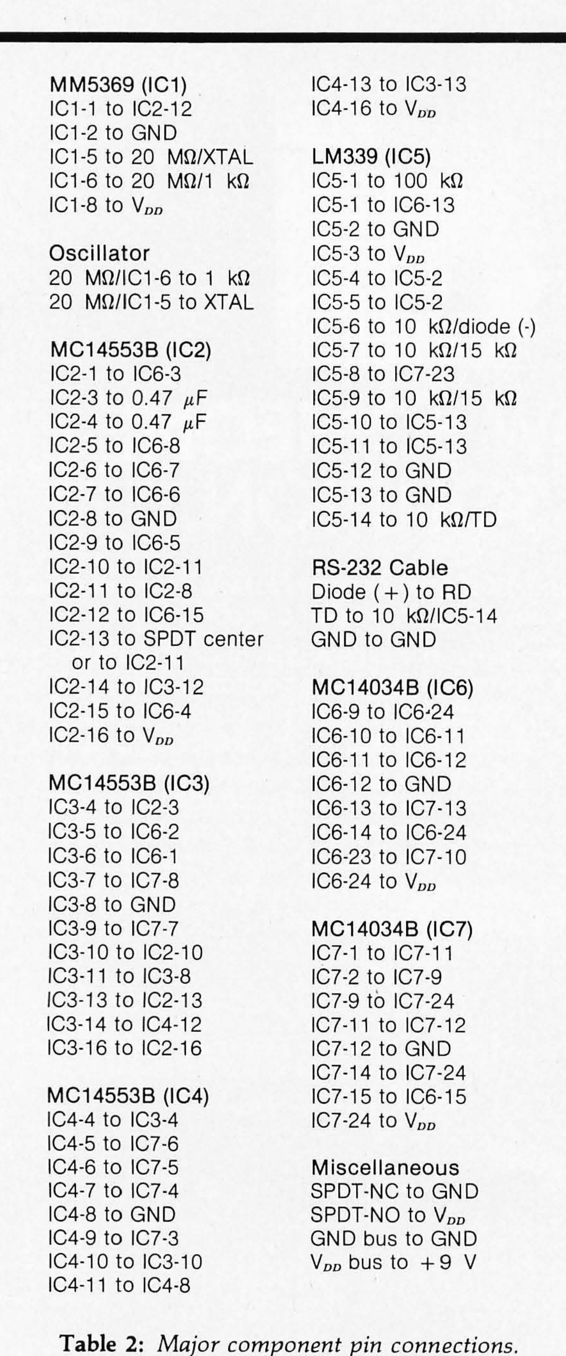
The V_{DD} and ground leads can be connected directly to the two buses. No power switch is used. The three leads to the serial port can be made from three-conductor ribbon cable routed into the battery compartment of the case and between the compartment cover (see figure 6). The opposite end of the ribbon cable connects to the 4-pin male DIN plug (see figure 7).

Testing the Hardware

After you've assembled the board, test the interconnections, referring to table 2 and figure 4. Invariably, there will be one or two miswires. (I once wired 10 chips in mirror-image fashion—pin 1 to 24, 2 to 23, etc.; you should be in better shape than this!)

Use two common straight pins, clip leads, and an ohmmeter or continuity tester to check all connections before installing the ICs in their sockets. When you're confident that all the connections are proper, plug in the ICs. CMOS is not as intolerant of static electricity as it once was, but avoid handling the chips more than necessary.

Plug in the 9-V battery, and you should be in operation. If you have an oscilloscope, check between pin 3 of IC4 and ground. The scan clock



MM5369 (IC1)
IC1-1 to IC2-12
IC1-2 to GND
IC1-5 to 20 MΩ/XTAL
IC1-6 to 20 MΩ/1 kΩ
IC1-8 to V_{DD}

Oscillator
20 MΩ/IC1-6 to 1 kΩ
20 MΩ/IC1-5 to XTAL

MC14553B (IC2)
IC2-1 to IC6-3
IC2-3 to 0.47 μF
IC2-4 to 0.47 μF
IC2-5 to IC6-8
IC2-6 to IC6-7
IC2-7 to IC6-6
IC2-8 to GND
IC2-9 to IC6-5
IC2-10 to IC2-11
IC2-11 to IC2-8
IC2-12 to IC6-15
IC2-13 to SPDT center
or to IC2-11
IC2-14 to IC3-12
IC2-15 to IC6-4
IC2-16 to V_{DD}

MC14553B (IC3)
IC3-4 to IC2-3
IC3-5 to IC6-2
IC3-6 to IC6-1
IC3-7 to IC7-8
IC3-8 to GND
IC3-9 to IC7-7
IC3-10 to IC2-10
IC3-11 to IC3-8
IC3-13 to IC2-13
IC3-14 to IC4-12
IC3-16 to IC2-16

MC14553B (IC4)
IC4-4 to IC3-4
IC4-5 to IC7-6
IC4-6 to IC7-5
IC4-7 to IC7-4
IC4-8 to GND
IC4-9 to IC7-3
IC4-10 to IC3-10
IC4-11 to IC4-8
IC4-13 to IC3-13
IC4-16 to V_{DD}

LM339 (IC5)
IC5-1 to 100 kΩ
IC5-1 to IC6-13
IC5-2 to GND
IC5-3 to V_{DD}
IC5-4 to IC5-2
IC5-5 to IC5-2
IC5-6 to 10 kΩ/diode (-)
IC5-7 to 10 kΩ/15 kΩ
IC5-8 to IC7-23
IC5-9 to 10 kΩ/15 kΩ
IC5-10 to IC5-13
IC5-11 to IC5-13
IC5-12 to GND
IC5-13 to GND
IC5-14 to 10 kΩ/TD

RS-232 Cable
Diode (+) to RD
TD to 10 kΩ/IC5-14
GND to GND

MC14034B (IC6)
IC6-9 to IC6-24
IC6-10 to IC6-11
IC6-11 to IC6-12
IC6-12 to GND
IC6-13 to IC7-13
IC6-14 to IC6-24
IC6-23 to IC7-10
IC6-24 to V_{DD}

MC14034B (IC7)
IC7-1 to IC7-11
IC7-2 to IC7-9
IC7-9 to IC7-24
IC7-11 to IC7-12
IC7-12 to GND
IC7-14 to IC7-24
IC7-15 to IC6-15
IC7-24 to V_{DD}

Miscellaneous
SPDT-NC to GND
SPDT-NO to V_{DD}
GND bus to GND
V_{DD} bus to +9 V

Table 2: *Major component pin connections.*

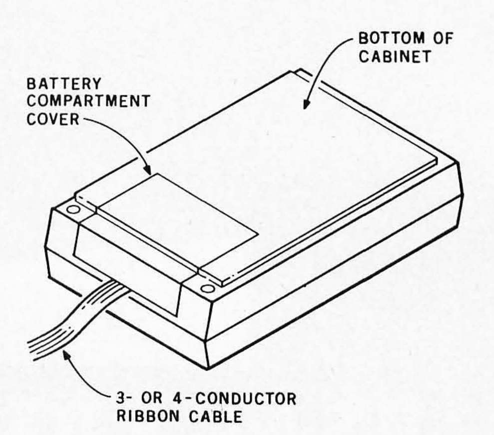


Figure 6: *The ribbon cable can be brought out between the cover of the battery compartment and the project case.*

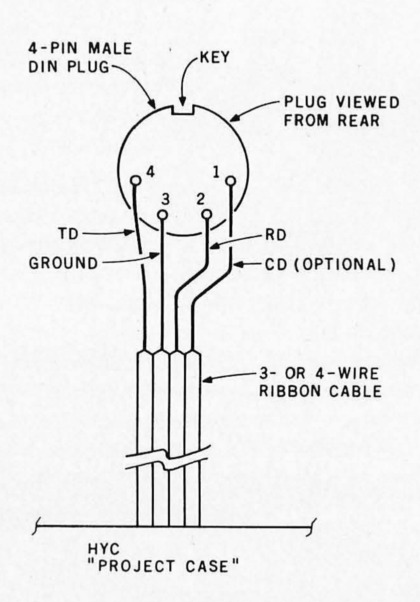
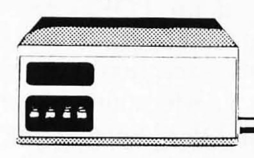
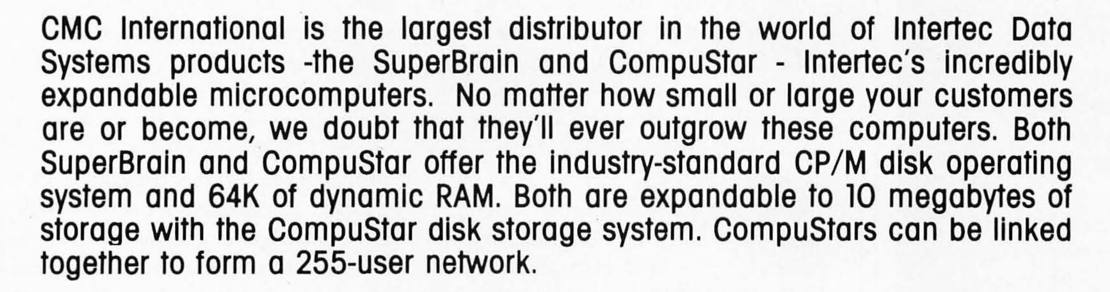


Figure 7: *A 4-pin male DIN connector is used to link the half-year clock to the Color Computer's RS-232C jack on the rear of the computer.*

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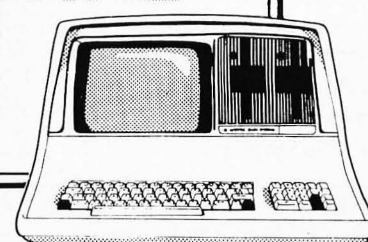


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should be operating at about 3 Hz. If it's slower than 3 Hz, try lower values than the 1-μF capacitor connected between pins 3 and 4 of IC2. Also, check the oscillator/divider output. You should see a clean 60-Hz square wave.

HYC Software

The HYC, in keeping with the traditions of the Color Computer system, is largely software dependent. Listing 1 shows a 6809 assembly-language program that reads data from the HYC. It resides in the upper 256 bytes of RAM (in a 16K Color Computer system). Protect this area by a CLEAR 200,&H3EFF when running the program with BASIC. Key in the 97 bytes of the program or use POKEs and DATA statements in your BASIC program.

With the exception of 2 bytes, the program is relocatable. Change the second and third bytes of the second instruction (locations 3F05 to 3F06 hexadecimal in listing 1) if you

How the HYC Program Works

The Clock I/O Handler (listing 1) is divided into three parts: the DELAY subroutine, the INPUT subroutine, and the main loop CLOCK.

The DELAY subroutine delays in multiples of 0.8333 second. One 60-Hz pulse has a duration of 16.666 milliseconds. This subroutine can be conveniently used for delaying in multiples or submultiples of one 60-Hz bit time.

The INPUT subroutine makes a single read of 16 bits of data from the counters. The BSR instruction at INPUT calls INPUA, resulting in the code from INPUA through the RTS instruction being executed twice. Eight bits of data are read on each pass through the section of code.

The loop at INP010 reads in eight data bits from port FF22 hexadecimal. Bit 0 is shifted right into the carry condition code and then rotated into the byte pointed to by the user stack pointer. The byte is initially cleared to 0. At the end of the second pass through INPUA, 2 bytes of data have been stored in the user stack, representing one complete read of three digits.

The main loop at CLOCK performs consecutive calls of the INPUT subroutine until three samplings of DS1, DS2, and DS3 have been compiled in the 6 bytes of the buffer. First, a 1 is output to bit 1 of port FF20 hexadecimal, bringing the HYC's P/S signal to a 1 (parallel data input mode). A delay of 1.9 cycles is provided so that the data can be clocked into the bus registers.

After the delay, the serial output is started by outputting a 0 to bit 1 of port FF20 hexadecimal, bringing P/S to a 0 (serial data input mode). Immediately after the output, the serial datum is checked by reading port FF22 hexadecimal bit 0. If the datum is a 1, the first clock occurred too close to the initialization of the process, and the process is repeated from CLK010. If the datum is a 0, a delay of 1/10 cycle is done and a test for 0 is done again; if the datum is not 0, the clock occurred within 1/10 cycle (close to the edge of a bit time), so the process is repeated.

If the first bit is a 0, the loop at CLK020 delays until the appearance of a 1. At this point, the second clock has just occurred. A delay of 1½ cycles is then done to position the next read in the middle of the third data bit time. The INPUT subroutine is then called to read in the next 16 bits. The last two of these are always zeros.

Now, the scan number of the first 16 bits is tested. If not equal to binary 11, or DS1, the process is repeated from CLK010. If equal to DS1, the user stack pointer is adjusted, the scan number is adjusted to 2, and another read from CLK010 is done to read the DS2 cycle. A third iteration reads the last cycle, DS3.

The short subroutine at GETSER gets the serial bit and tests it, changing the Z condition code to zero or nonzero.

relocate the program. These 2 bytes should hold the address of a 6-byte buffer.

A simple BASIC test program is shown in listing 2. This program defines the location of the program by the DEFUSR0 statement. (Change this statement if you have relocated the machine-language code.) The assembly-language program is entered by the USR0 call and returns with 6 bytes of the current clock count in locations 3FF0 through 3FF5 hexadecimal. These six locations represent the BCD digits and scan numbers as shown in figure 8. Sample outputs are shown in figure 9.

Text continued on page 122

Listing 2: *This short BASIC program calls the clock I/O handler and displays the 6 bytes of data that were read.*

```
100 DEFUSR0=&H3F00
110 A=USR0(0)
120 FOR I=&H3FF0 TO &H3FF5
130 PRINT PEEK(I),
140 NEXT I
150 PRINT:PRINT:GOTO 110
```

Listing 1: *The clock I/O handler is a three-section, assembly-language program that reads in 6 bytes of the count into a buffer at location 3FF0 hexadecimal.*

```
3F00                00100          ORG     $3F00
          3FF0      00110 BUFFER   EQU     $3FF0
                    00120 ***************************************************
                    00130 * CLOCK I/O HANDLER. READS IN 3 CLOCK COUNTS      *
                    00140 ***************************************************
3F00 108E 0003      00150 CLOCK    LDY     #3       SCAN #
3F04 CE   3FF0      00160          LDU     #BUFFER
3F07 86   02        00170 CLK010   LDA     #2         2 TO A
3F09 B7   FF20      00180          STA     $FF20      STROBE IN NEXT COUNT
3F0C 86   26        00190          LDA     #38        1.9 CYCLE COUNT
3F0E 8D   47        00200          BSR     DELAY      DELAY 1.9 60HZ CYCLES
3F10 B7   FF20      00210          STA     $FF20      START SERIAL
3F13 8D   25        00220          BSR     GETSER     GET SERIAL IN
3F15 26   F0        00230          BNE     CLK010     GO IF INVALID
3F17 86   02        00240          LDA     #2         DELAY COUNT
3F19 8D   3C        00250          BSR     DELAY      DELAY 1/10 CYCLE
3F1B 8D   1D        00260          BSR     GETSER     GET SERIAL IN BIT
3F1D 26   E8        00270          BNE     CLK010     GO IF INVALID
3F1F 8D   19        00280 CLK020   BSR     GETSER       GET SERIAL IN BIT
3F21 27   FC        00290          BEQ     CLK020       GO IF 0
3F23 86   1E        00300          LDA     #30        1+1/2 CYCLE COUNT
3F25 8D   30        00310          BSR     DELAY      DELAY 1+1/2 CYCLE
3F27 8D   17        00320          BSR     INPUT      READ CLOCK COUNT
3F29 33   5E        00330          LEAU    -2,U       RESET PNTR
3F2B 1F   20        00340          TFR     Y,D        SCN # NOW IN B
3F2D E8   41        00350          EORB    1,U        TEST SCN #
3F2F C4   03        00360          ANDB    #3         MASK OUT DIGIT
3F31 26   D4        00370          BNE     CLK010     GO IF NOT PROPER SCN #
3F33 33   42        00380          LEAU    2,U        POINT TO NEXT 2 BYTES
3F35 31   3F        00390          LEAY    -1,Y       DECREMENT SCN #
3F37 26   CE        00400          BNE     CLK010     GO IF NOT DONE
3F39 39             00410          RTS              RETURN
3F3A B6   FF22      00420 GETSER   LDA     $FF22    GET SERIAL BIT
3F3D 84   01        00430          ANDA    #1       TEST
3F3F 39             00440          RTS              RETURN
                    00450 ***************************************************
                    00460 * INPUT. INPUTS 14 BITS AND STORES IN TWO BYTES   *
                    00470 *  ENTRY:  BUFFER ADDRESS IN U                     *
                    00480 *  EXIT:   2 BYTES STORED IN BUFFER, U UPDATED     *
                    00490 ***************************************************
3F40 8D   00        00500 INPUT    BSR     INPUA    GO TWICE
3F42 4F             00510 INPUA    CLRA             0 TO A
3F43 A7   C4        00520          STA     ,U       CLEAR BYTE
3F45 C6   08        00530          LDB     #8       FOR 8 BITS
3F47 B6   FF22      00540 INP010   LDA     $FF22      GET BIT
3F4A 44             00550          LSRA               OUT TO C
3F4B 66   C4        00560          ROR     ,U         MERGE IN USER STACK
3F4D 86   14        00570          LDA     #20        1 CYCLE COUNT
3F4F 8D   06        00580          BSR     DELAY      DELAY 1 CYCLE
3F51 5A             00590          DECB               DECREMENT ITERATION COUNT
3F52 26   F3        00600          BNE     INP010     GO IF NOT 8
3F54 33   41        00610          LEAU    1,U      POINT TO NEXT STACK BYTE
3F56 39             00620          RTS              RETURN (AGAIN OR CLOCK)
                    00630 ***************************************************
                    00640 * DELAY. DELAYS IN MULTIPLES OF .83333 MS         *
                    00650 * ENTRY:  COUNT IN A                              *
                    00660 * EXIT:   AFTER DELAY                             *
                    00670 ***************************************************
3F57 8E   005C      00680 DELAY    LDX     #92        FINAGLE FACTOR
3F5A 30   1F        00690 DEL010   LEAX    -1,X         DECREMENT X
3F5C 26   FC        00700          BNE     DEL010       GO IF NOT 0
3F5E 4A             00710          DECA               DECREMENT MAJOR COUNT
3F5F 26   F6        00720          BNE     DELAY      GO IF NOT 0
3F61 39             00730          RTS              RETURN
          0000      00740          END
```

HEXADECIMAL LOCATION			
3FF0	DIGIT D	DIGIT G	
3FF1	0 0	DIGIT A	1 1
3FF2	DIGIT E	DIGIT H	
3FF3	0 0	DIGIT B	1 0
3FF4	DIGIT F	DIGIT J	
3FF5	0 0	DIGIT C	0 1

SCAN NUMBER

J H G F E D C B A

10^0, 10^1, 10^2, 10^3, 10^4, 10^5, 10^6, 10^7, 10^8

UP TO 999,999,999 COUNTS IN UNITS OF 1/60 SECOND (16,666,666 SECONDS OR 192 DAYS)

Figure 8: *The 6 bytes of count data from the half-year clock contain nine BCD digits and three scan numbers. The order is based on the functional layout of the hardware and the data must be rearranged by the interface software.*

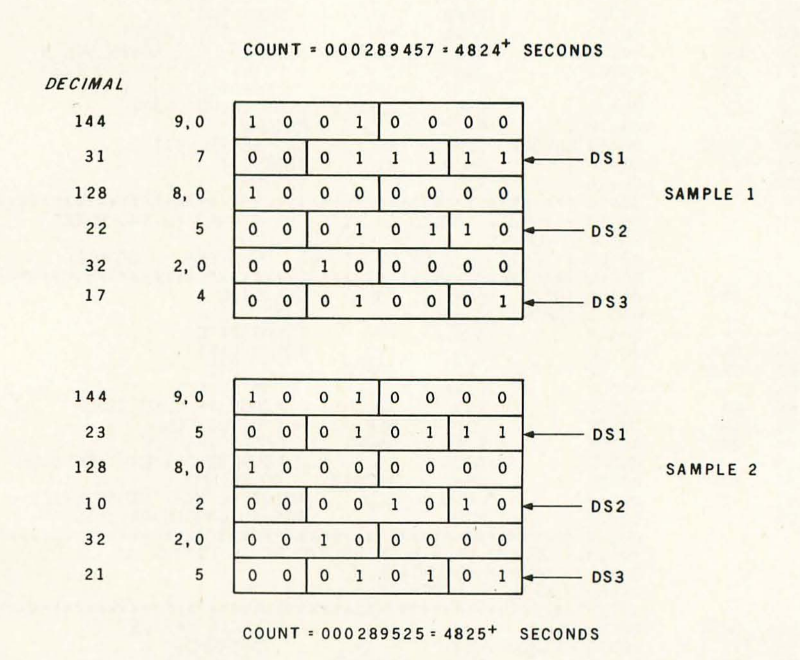


Figure 9: *These are typical data samples. Sample 1 represents a count of 000289457, or 4824.XX seconds. Sample 2 occurred after sample 1 and represents the next count of 000289525, or 4825.XX seconds.*

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Listing 3: *This BASIC program interfaces to the assembly-language clock driver. It converts the 6 bytes of clock data into a count of days, hours, minutes, and seconds, and checks for error conditions.*

```
100 INPUT "TIME IN 60THS";T2
110 CLS
120 DEFUSR0=&H3F00
130 T0=-1
140 A=USR0(0)
150 A=INT(PEEK(&H3FF1)/4)
160 B=INT(PEEK(&H3FF3)/4)
170 C=INT(PEEK(&H3FF5)/4)
180 D=INT(PEEK(&H3FF0)/16)
190 E=INT(PEEK(&H3FF2)/16)
200 F=INT(PEEK(&H3FF4)/16)
210 G=(PEEK(&H3FF0) AND 15)
220 H=(PEEK(&H3FF2) AND 15)
230 J=(PEEK(&H3FF4) AND 15)
240 T1=(J*100000000+H*10000000+G*1000000+F*100000+E*10000+D*1000+C*100+B*10+A)
245 IF T0=-1 THEN T0=T1
250 IF T1<T0 THEN GOTO 140 ELSE IF T1-T0>999 THEN GOTO 140 ELSET0=T1
260 T3=T1+T2: IF T3>999999999 THEN T3=T3-999999999
270 T3=INT(T3/60)
280 D=INT(T3/86400):H=INT((T3-D*86400)/3600):M=INT((T3-D*86400-H*3600)/60):S=T3-
D*86400-H*3600-M*60
290 PRINT @ 256, "DAY";D;H;"HOURS";M;"MINS";S;"SECS"
300 GOTO 140
```

Text continued from page 117:

A general-purpose BASIC driver is shown in listing 3. This program displays the actual number of days, hours, minutes, and seconds represented by the count in the HYC. This count can be held in a Color Computer BASIC variable, which allows nine decimal digits of precision.

A "bias" count can be input to the program before sampling the HYC. This bias may be positive or negative to adjust the current count to a previous starting point or to "trim" the time. The unit of bias is $\frac{1}{60}$ second. Thus, use a value of 60 for every second, 3600 for every minute, 216,000 for every hour, or 518,400 for every day. The momentary-contact RESET switch resets the entire count to 0.

The tests of the current count (T1) with the previous count (T0) require some explanation. In most cases, the sampling process reads count data in a "nonchanging" state. However, because the scan clock occurs at unpredictable times, the count may be sampled in the middle of a scan clock "edge," yielding invalid data. Because of this, T1 (current) is compared to T0 (old). If T1 is less than T0, T1 is invalid and another sample is made. If T1 is greater than T0 by 999 counts (16.65 seconds), T1 is considered invalid and another sample is made. The typical display generated by the program shows the time changing every 2 seconds, with occasional lapses of up to 4 seconds.

Tests run over several days showed less than one (detected) invalid read per minute with a maximum delay of 5.5 seconds. No invalid times appeared.

If the HYC is to be called at random times, make three calls and test for ascending counts with a difference of less than 10 seconds or so. Using this method, the resulting time will be accurate to within 10 seconds of the counter time.

The crystal used should provide an excellent time base. It can be fine-tuned, however, by substituting a 5 to 50-picofarad (pF) "trimmer" capacitor in place of the 4.7-pF capacitor connected to the crystal.

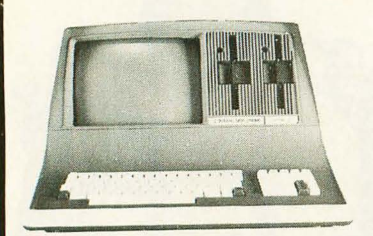
In operation, the HYC can be disconnected from the system at any time (without turning off the Color Computer) and left running. It can be reconnected at any later time. (Stop the BASIC program above if this is done to prevent a hang-up caused by T1-T0 being greater than 999.)

If Rip van Winkle had owned a Color Computer, he would have loved the half-year clock. If you have nothing to do for the next 192 days, why not check this project out with your Color Computer to test its accuracy? Or count clock pulses instead of sheep: 999,998,767; 999,998,768; 999,998,769 (yawn) . . .■

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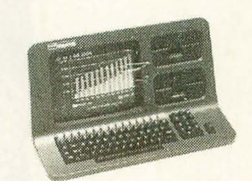


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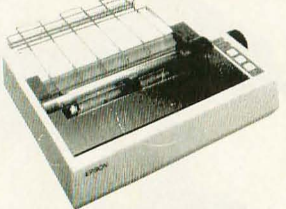
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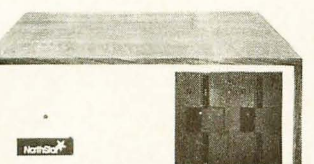
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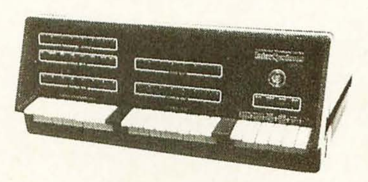
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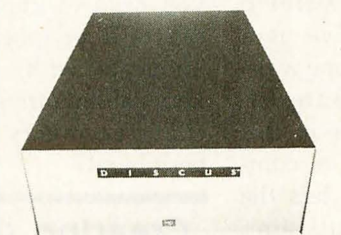
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The Input/Output Primer

Part 2: Interrupts and Direct Memory Access

Steve Leibson
Auto-Trol Technological Corporation
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Last month we left the computer waiting patiently for the printer to signal its readiness to receive another character. If you think it's wasteful to make a machine as expensive as a computer spend most of its time waiting on slower equipment, you are definitely thinking ahead. Later in this month's article, I'll explore a communication mechanism that lets the computer work on another task after transmitting a piece of information. This mechanism, known as the *interrupt*, enables the computer to go about its business until the printer is ready for more data. First, though, you need to know how a computer selects a peripheral device to communicate with; you also need to know about *interfaces*—the hardware that connects computers and peripherals.

This article is the second in Steve Leibson's six-part series, "The Input/Output Primer." The series will explain the way in which computers talk with the world. Upcoming articles will discuss parallel and HPIB (GPIB) interfaces; BCD and serial interfaces; character codes; and interrupts, buffers, grounds, and signal degradation. An I/O Glossary, *which defines many terms used in these articles, appeared with the first installment (February 1982 BYTE, page 122). Figure and table numbers are continued from Part 1.*

Creating subaddresses ensures that information of different kinds can be directed to the proper section of the device.

Picking and Choosing

In the first article of this series, I briefly discussed *peripheral address lines*. Computers, which generally have several peripheral devices attached, select a particular device in one of two ways. One method is to have a separate I/O connection for every device connected. Selecting a particular device is merely a matter of sending information on the proper bus. This technique, however, rapidly creates a rat's nest of wires, something that's impractical to manufacture.

An I/O *bus* has a set of peripheral-address lines that the processor uses to specify a device. This greatly simplifies wiring the system and results in major cost savings, although it does limit the computer to communicating with one peripheral at a time. For most computer processors, though, one is the limit anyway.

Multiplexing Peripherals

Peripheral-address lines allow the I/O bus to be shared or *multiplexed* by many devices. Each device must have a unique address on the bus. Otherwise, conflicts will arise when two devices try to use information on the bus simultaneously. For instance, plotters are useful for graphing data but are terrible for listing programs.

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When the computer is accessing the disk storage device, everything will run more smoothly if the plotter ignores transactions on the I/O bus.

Clearly, each peripheral device must have its own unique address. It's more advantageous, however, for each device to have several unique addresses. Think of the peripheral device as an apartment building having a single, unique street address. Apartment One gets the local daily newspaper, which covers general information, while Apartment Two gets *The Wall Street Journal*, which reports on economic events. Each apartment gets information but of a different kind.

A peripheral device also requires information of different kinds. Not only do printers receive characters to print, but they also get control information such as line spacing, number of characters to print per line, type font, and other functions. Creating subaddresses within the peripheral device ensures that information of different kinds can be directed to the proper section of the device.

Peripheral address lines are split into a *select code* that specifies a particular peripheral and a *register code* that specifies the subaddress. (A *register* is a hardware device that holds the information until the peripheral can use it.)

Setting up Subaddresses

To illustrate, I'll create four subaddresses within each select code. Being obstinate, as computer designers often are, I'll call these subaddresses 4, 5, 6, and 7 (nobody starts at zero any more). These four subaddresses are registers that serve as portals to the peripheral.

Four subaddresses require two wires for selection because two wires can assume four binary states. These states are:

State of line #1	State of line #2	Register addressed
0	0	4
1	0	5
0	1	6
1	1	7

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assume one of two states: on or off, "1" or "0.")

Although four registers could do the job, there's a complication: the data lines are bidirectional, and bidirectional registers are complex to construct. It's easier to use eight registers—four for input and four for output. The I/O line will specify from which group of four the register address lines will select. Remember that the I/O line specifies the direction of data flow on the data lines and so is ideal for selecting between the input and output registers.

I've now constructed a simple I/O bus that can convey information between the computer and external devices. This I/O bus isn't the most advanced, but it will satisfy present needs. I'll upgrade this "bunch of wires" later, but first let's confront a more pressing problem.

Introduction to Interfaces

The I/O bus discussed above is a subset of the bus used in the Hewlett-Packard desktop computers, model 9825 and Systems 35 and 45. It would be convenient if all peripherals came with circuitry that directly interfaced to the I/O bus.

Unfortunately, present interfacing methods are far from ideal. The bus constructed above is *parallel-oriented*, which means that every binary digit (bit) of a piece of information (such as a character) is available simultaneously on the 16 data lines.

Not all peripherals use 16 data lines; some peripherals don't have any parallel interfaces but instead send information one bit at a time in a time-serial fashion. No peripherals use the eight-register scheme discussed above, while several use incompatible voltage levels to represent "1" and "0." This appears to be quite a problem. In fact, there isn't a single peripheral that can talk to our I/O bus in its present state.

Interfaces as Translators

It's necessary to interpose some specialized circuitry between the I/O bus and the peripheral device to adapt the signals from the computer to those used by the peripheral. This

specialized circuitry is called an *interface*. The interface, which actually plugs into the I/O bus, acts as an intermediary, translating voltages, signal formats, and whatever else is required to establish communications between the computer and the peripheral.

If every peripheral manufactured in the last decade required a different interface, it would be impossible for the computer to communicate with even a small fraction of them. Computer manufacturers simply cannot make products for that many different interfaces. Fortunately, several devices require only one of four basic types of interface: parallel I/O, serial I/O, HPIB (GPIB), and BCD (binary-coded decimal).

To connect with a peripheral, the parallel interface uses a set of wires much like those of the I/O bus. This interface is the most common among current peripherals because it's the simplest to build and usually transfers data the fastest. Major variations involve (1) the connector used between the peripheral and the interface circuitry and (2) the sense of the data and control lines. Does zero volts mean logic zero (positive true logic) or logic one (negative true logic)?

A *flexible* parallel interface should be available with several connectors and an unterminated cable so that a custom connector can be installed. The logic sense of the data and control lines and even the logic levels used can all be adjusted to suit the needs of a particular device.

A serial interface takes data from the I/O bus and serializes it into a stream of bits. Incoming serial data is converted into parallel data and sent to the computer. Only two wires are required for serial communications—transmit data and receive data—however, control lines exist in serial interfaces because serial I/O dominates the special environment of long-distance data communications.

Interrupts force the processor to leave the part of the program it's executing and start executing the code in a different location in memory.

HPIB, a relatively new interface, is standardized. HPIB stands for Hewlett-Packard Interface Bus. Due to standardization, it's also known as the General Purpose Interface Bus (GPIB). Formally known as IEEE-488-1978, HPIB has well-defined signals, connector, logic sense, and logic levels. This interface allows simple connection to multiple devices over a bus structure. Since the connector and signals are standardized, you just bolt the connecting cable to the peripheral for the computer to begin communicating. You then can concentrate on the software needed to run the peripheral. A single HPIB interface can connect a computer to 14 peripheral devices.

Older instruments use a different type of interface known as binary-coded decimal (BCD). Data is transferred in 4-bit chunks, and each group of 4 bits represents a numeral (0 through 9). BCD interfaces are generally used for transmitting numeric information.

In the third and fourth installments of this primer, I'll examine these types of interfaces in depth. For now, though, let's turn to this month's main topic, interrupts and direct memory access (DMA).

Getting the Processor's Attention

What do you think is the most important part of a telephone? The dial? The receiver? The cord? I submit that it's the bell. If the telephone had no way to summon you when a call came in, you'd have to check it periodically to see if there was someone on the line. Having to lift the receiver every few minutes would make the instrument a maddening inconvenience. Fortunately, telephones do have bells that interrupt you when someone calls.

Earlier I discussed the relative speeds of computer processors and peripheral devices. The mismatch in speeds forced the creation of *handshaking* lines the processor could check to determine the peripheral's availability. Without these lines, the speedy processor would inundate the poor peripheral with data. Using these handshake lines is the simplest form of I/O. The computer spends much of its time patiently waiting for the peripheral to signal readiness for

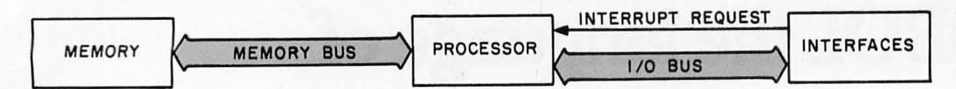


Figure 4: *A computer system with memory bus, I/O bus, and added interrupt line. Interrupts allow the processor to start I/O processes, then go on to other tasks. The peripheral uses the interrupt line to indicate readiness for another transaction.*

the next transaction.

Interrupting

Waiting for peripherals is tolerable if the computer has nothing else to do. Often, however, there are many other things the computer could be doing, making the handshaking I/O highly inefficient. Fortunately, most computers now offer an alternative called *interrupt I/O*.

Let's first make clear exactly what will be interrupted. The computer is continuously executing a program in its memory. If there's no user program running, then at least the operating system will be. Thus there are at least two program levels in the computer, with the higher level being the user program, usually written in a language such as BASIC.

Because microprocessors can't run a BASIC program directly (although that day isn't far off), they use a lower-level program called an *interpreter*, which is written in a machine language the processor *can* run directly. The interpreter takes the BASIC program and interprets it by deciding which machine-language routines to call to perform the tasks requested in the BASIC program. Another type of lower-level program, a *compiler*, can translate a high-level language program into machine code. I'll consider only interpreters here.

Interrupts are hardware mechanisms that force the processor to leave the part of the program it's executing and start executing the code in a different location in memory. Figure 4 shows the I/O bus with an interrupt request line added. That's the only change the bus needs in order to add interrupt capability.

Interruption takes place at the machine-code level. It's helpful in synchronizing external events with the computer program but must be used carefully. Let's take an example.

Suppose a user program asks the computer to calculate the value of 2.5 + 2.5, produce the resulting value on a printer, then calculate the value of 3 + 3. The computer will first execute the BASIC interpreter's routine for floating-point addition and produce the first sum: 5.00. Then there will be six characters to print: 5, ., 0, 0, <CR>, and <LF>. <CR> and <LF> are carriage return and linefeed characters usually sent to advance the printer to the next line on the paper.

Assume the addition takes around two milliseconds. If the printer produces ten characters per second, it will take 0.6 seconds to print the first answer (actually, a little more time will be needed because carriage return and linefeed take extra time on most printers).

Handshake I/O requires the computer to wait the full 0.6 seconds before calculating the second sum because the computer is waiting to send the printer another character during that time.

Interrupt I/O's alternative is to place characters to be printed in a buffer somewhere in memory. Interrupt routines can then withdraw characters from this buffer whenever the printer can accept them, and the computer can push on through the program.

Interrupting Machine Code

When the first character to be printed is removed from the buffer and sent to the printer, the printer interface "goes busy," transferring the character to the printer and waiting for a signal that indicates completion of the printing. Meanwhile, the computer can proceed to the next BASIC statement. When that first character has finally been printed, the printer will "go ready" for the next one. At that time, the printer interface will interrupt the processor and request another character.

Note that the machine code interpreter is interrupted, *not* the BASIC program. The flow of execution of the BASIC statements is not changed but merely halted while the interruption is serviced. The interpreter, however, does branch to a different routine. This special routine, also in machine code, is called an interrupt service routine. The author of the BASIC program doesn't have to write interrupt service routines for Hewlett-Packard desktop computers, as needed routines are provided in the interpreter. This is convenient because interrupt service routines must handle many factors.

An interrupt forces a branch to the location in memory where the interrupt service routine is stored. If the processor doesn't remember where it was before the interruption, the processor will be unable to return to that location. In fact, the processor will be "lost" and unable to continue processing. Most microprocessors automatically save the address of the location being executed before the interrupt, and a return from the interrupt is sufficient to store that address.

If the interrupt routine uses any of the internal registers in the processor, the routine must carefully save the contents of these registers before using them. This procedure is called *context switching* because the registers will be used for a different purpose in the interrupt service routine than in the main program. Upon completion of the interrupt service routine, the routine must restore the saved values of the registers.

Interrupting BASIC

Occasionally, the buffered I/O routines for servicing interrupts are not sufficient for handling a problem. Some interrupts are more complex than those needed for data transfer. Maybe the computer is monitoring a water system and the dam bursts. Such crises require the processor's immediate attention; a simple data transfer will not suffice. A branch is needed in the high-level program to a special high-level routine written to handle the interrupt. You *did* write the "Dam Burst" routine, didn't you?

Interrupting a program in BASIC or another high-level language is considerably more complex than inter-



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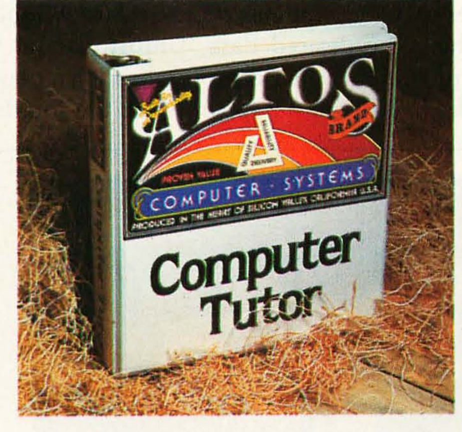
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rupting a machine-language routine for data transfer. High-level statements can affect large portions of memory through the use of variables, arrays, and strings. If a variable is in the process of being changed when the interrupt comes in and the BASIC interrupt routine uses that same variable, the interrupt routine may use the wrong value or a garbled value. If the dam has burst and you need to close some locks downstream immediately to save a town, you and the townspeople have a strong interest in seeing that the interrupt routine uses the right value.

End of the Line

To prevent such problems, Hewlett-Packard desktop computers allow the BASIC program to be interrupted only at the completion of program line execution. This feature is called *end-of-line branching* because the branch to a BASIC interrupt service routine is allowed only when the end of a line is reached. The interrupt may occur at any time and will be logged in, but it will not be serviced until the end of the current program line.

Machine-code or low-level interrupts are generally called *hardware interrupts* because the processor hardware grants the interrupt request and performs the subsequent branching. Interrupts to the BASIC or high-level program are called *software interrupts* because several instructions in the operating system are required to log in the interrupt, request an end-of-line branch, then take control of program flow at the end of the line.

A Misunderstanding

A classic example of misunderstanding interrupt operations occurs whenever a first-time writer of interrupt service routines tries to use an interrupt for input. The typical programmer will enable the interface to interrupt and expect that when the interrupt comes, the interface will have the desired data. Unfortunately, the interface interrupts when it isn't busy. This may happen when the interface wasn't told to do anything or when an operation has completed. Since the interrupt routine didn't originally make the interface busy by requesting a data input operation before the interrupt was enabled, the interface interrupts immediately but has nothing to offer. Such a miswritten interrupt routine always produces incorrect information on the first data transfer. Remember, to use interrupts properly, you must see that data transfer is started before interrupts are enabled. That way, the first interrupt will occur when the first data transfer is complete.

DMA: The I/O Superhighway

Thus far, I've covered the hardware within a computer and the interfacing circuitry necessary to interface peripheral devices with computers. All the discussions have assumed that the computer processor is in control of the data-transfer process, which is true for many peripheral devices. The processor is usually fast enough so that the peripheral determines the data-transfer rate.

Some devices, however, are too fast for processor-controlled I/O. These devices can handle data at rates approaching the speed of the computer memory and therefore require a different I/O technique. One technique for interfacing these fast peripherals is called direct memory access.

If the peripheral device is slightly slower than the computer processor, the processor may be able to execute only the few machine instructions needed for the I/O transfer before the peripheral is ready for another transfer. In that case, there's a good match between the I/O software and the peripheral speeds, and programmed I/O will suffice for the task.

Some peripherals, however, are too fast for the processor to execute even the few instructions needed to perform programmed I/O. As long as these peripherals are not faster than the computer's basic memory cycle, direct memory access can perform the required I/O.

In order to discuss DMA and how it works, we must return to the model of the processor/memory/I/O sys-

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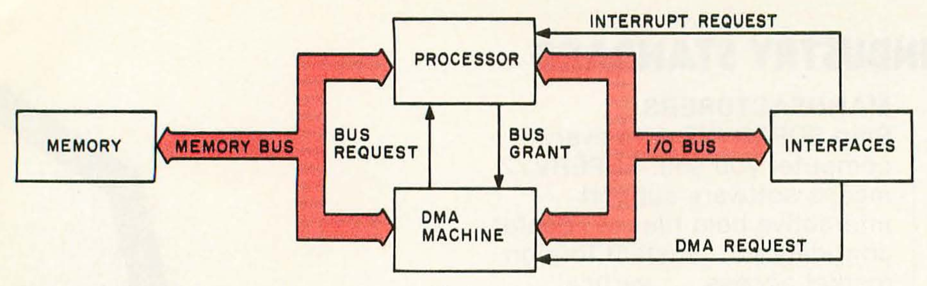


Figure 5: *A computer system with an added DMA (direct memory access) machine. The DMA machine, which parallels the processor, can generate the signals necessary for controlling both the memory bus and the I/O bus.*

tem. Recall that the processor is linked to the memory via a set of lines called a memory bus and to the I/O interfaces via an I/O bus. Both buses require the processor to generate address signals and control signals to synchronize the flow of data over these buses.

Generally, I/O consists of taking information from the interfaces through the I/O bus and transmitting this information to the memory using the memory bus—or vice versa. During this transfer, the processor is also using the memory and memory bus to supply machine instructions so that it knows how to effect the data transactions. If you assume that the processor takes only nine machine instructions to perform one data transaction, you can see that the effective I/O throughput is only ten percent of the rate that the memory could support. That is, of every ten memory cycles, nine instruct the processor and only one places data for I/O. Only the simplest data transactions can be performed with nine machine instructions. Formatting and code conversions require many more instructions.

The only way to speed up the I/O process is to eliminate the slowest link in the data path. For high-speed peripherals, the slowest link is clearly the processor itself! How can you eliminate the processor when it's the component that links the I/O and memory buses and is required for generation of the signals that actually make these buses work? The answer is to build a specialized circuit designed to transfer data at the full speed of memory. Since this transfer is the only function this circuitry must perform, the capability can be wired into the circuit. Instructions from memory, which would reduce the effective memory bandwidth, are not needed.

By placing this special circuitry so that it bridges the I/O and memory buses and also by giving it the capability of generating the address and control signals required by these buses, you then have a machine that can perform I/O at the full speed of memory. Such special circuitry is called a direct memory access machine. Figure 5 shows how one might add a DMA machine to the I/O bus.

All that remains is to decide which device will have control of the buses: the processor or the DMA machine. Normally, the processor will have control of the buses, since the DMA I/O must be infrequent enough to allow some processing to get done. The DMA machine must therefore have a way to acquire bus control from the processor whenever necessary. The processor can enable the DMA machine to request bus control, but the interface must actually request service through the DMA machine because only the interface knows when an attached peripheral requires DMA service. Thus some connecting signals must exist between the interface and the DMA machine and between the DMA machine and the processor. To give the interface a means of requesting service from the DMA machine, let's add a signal called *DMA Request* (DMAR) to the collection of signal lines on the I/O bus.

Upon receipt of a DMA Request, the DMA machine must request bus control from the processor. If the processor decides that the request comes at an inopportune time, it can temporarily withhold transfer of control. This is a job for the ever-present handshake! Let's create two handshake lines, *Bus Request* and *Bus Grant*. The DMA machine will ask for bus control with Bus Request and will take control after receiving a signal on Bus Grant. As a result, the processor can maintain control of the memory and address buses as long as required.

The kind of DMA I've been discussing is called *burst DMA* because the data transfer is done in a burst during which the DMA machine totally controls the memory and I/O buses. This provides the I/O with the full speed of the memory bus at the expense of completely halting processor activity. If half the memory bus bandwidth were sufficient to solve the high-speed I/O problem, we could use another type of DMA called *cycle-steal DMA*. In the cycle-steal arrangement, the DMA machine alternates control of the buses with the processor, each using every other memory cycle. Cycle-steal DMA allows the processor to operate at 50 percent efficiency while still providing relatively high-speed I/O.

Summary

It would simplify matters greatly if all devices could agree on data representation, format, signal levels, timing, or even the number of wires used for interconnection. Attempts at standardization have been made, but the swift pace of computer technology renders some standards obsolete before they're published. In addition, the need for compromises seems to arise with every new system. Older equipment also needs to be interconnected; otherwise, replacement of a computer would dictate replacement of the entire system.

Fortunately, present technology can reach backward as well as forward. The computer itself can make adaptations, since computers excel at changing one value into another. Furthermore, interface circuitry that links the computer's memory or I/O bus to the I/O of the peripheral device can overcome hardware incompatibility. Next month I'll discuss two basic types of hardware interface presently used in computer systems: the parallel and HPIB (GPIB) interfaces.■

A BASIC Plotting Subroutine

Sophisticated Plotting with Your MX-80

Lawrence J. Bregoli
106 South Longyard Rd.
Southwick, MA 01077

Since the introduction of the MX-80 printer, several articles have described most of its outstanding features, including the remarkable print quality for the price. I'd like to showcase another great feature of this printer: its ability to plot data curves. By combining its features with simple software routines, the MX-80 can emulate sophisticated plotters.

Plotter Criteria

Several features constitute a good plotting routine. First, it should be a subroutine that, when called, plots data generated in the main program and, if needed, returns to the main program with the data unmodified for further processing. Second, the plot routine should be automatically scaling so that the operator of the main program doesn't have to worry about keeping tabs on all the maximum and minimum values sent to the plotting routine. Last but not least, the hard-copy output should have enough resolution to allow interpretation of the data. After all, that's why a plot was deemed necessary in the first place.

Once a linefeed is generated, there's no turning back.

The MX-80 printer easily meets these criteria, as evidenced by figure 1. The plot is a straight line of the form $y = mx + b$. Note that the plotting routine provides its own graph paper by inserting horizontal and vertical grid lines; legends for both axes are included. Ah, you say, any print routine could handle a straight line with ease. Figure 2 is a better test of the printer and plotting routine. Here, concentric circles are plotted with radii of 1 and 0.5. Note that the auto-scaling routines in this case must handle both positive and negative values, and that, although the circles are not perfect, they have enough resolution for most plotting applications.

Resolution of these plots is set by the maximum number of data points allowed by the plotting routine. In the plots shown, the number of points was limited to 101 X,Y pairs. The number of points chosen was based on several criteria. First, the maximum number of print positions that can be set in the horizontal direction is 132. Using 101 of these positions for data plotting leaves 31 positions for printing the Y-axis scale values and the Y-axis title. In the vertical direction, the MX-80 can be set so that every linefeed increment moves the paper up by as little as $\frac{1}{72}$ inch. Therefore, resolution to a single printed dot can be obtained. I chose only 101 points in the vertical direction for several practical reasons. In most cases, this is all the resolution needed to obtain a smooth fit of the data. Most important, though, each data point plotted takes time to print, and the increased printing time is not warranted in most cases.

About the Program

The program for generating the plots, shown in listing 1, was written in Microsoft MBASIC 5. The size of the program can be cut down considerably by removing the REM statements and by combining several program lines into one multiple-statement line. As written, the program doesn't need a main program to gen-

About the Author

Lawrence J. Bregoli has a bachelor's degree in electrical engineering and is currently employed as a research engineer working on electrochemical aspects of fuel cell research at UTC in South Windsor, CT.

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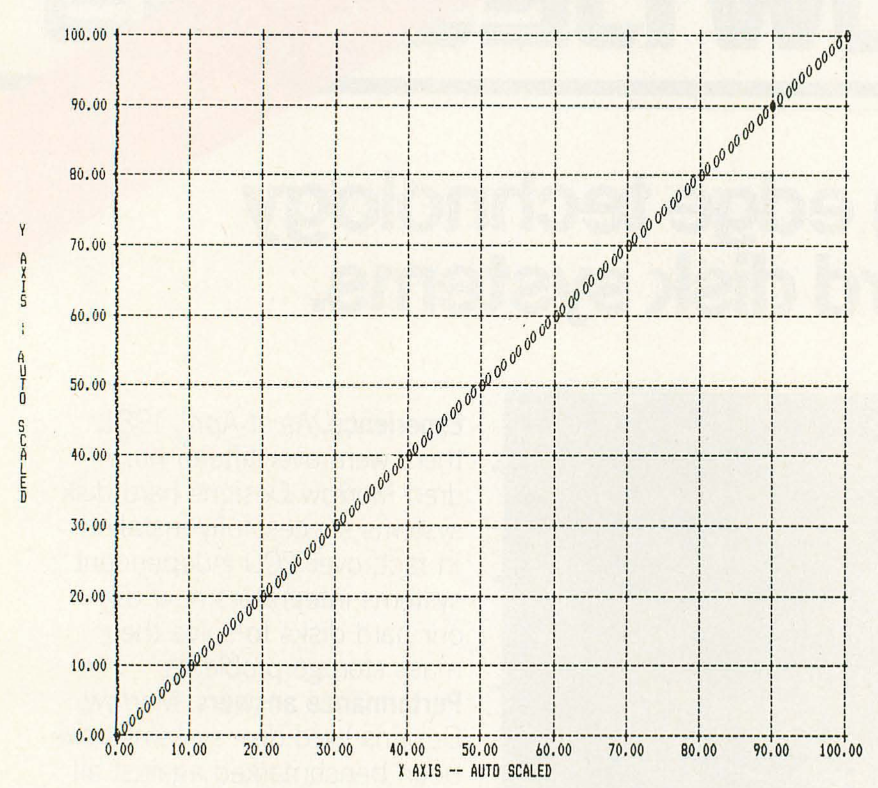
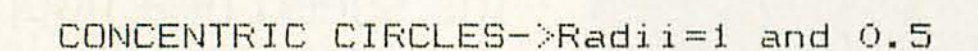


Figure 1: *Sample plot of a straight line using auto-scaling (y=mx+b, b=0).*



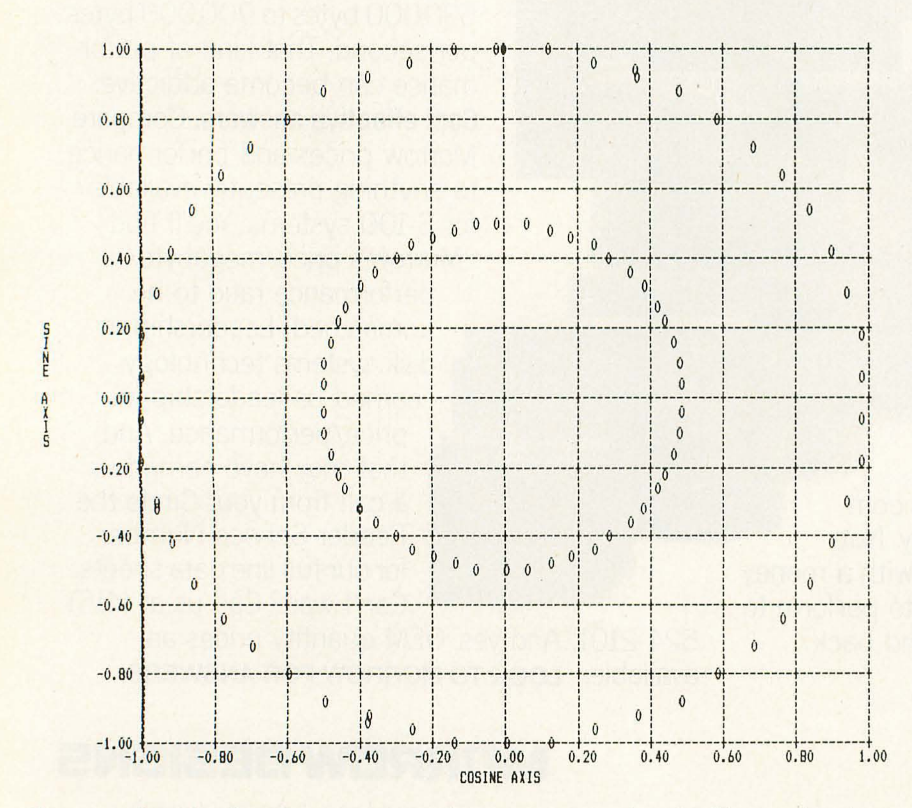


Figure 2: *Sample plot of concentric circles using auto-scaling (radii=1 and 0.5).*

erate X,Y data sets. It was written this way so that it could be tested immediately for errors using data generated in lines 5120 through 5200. In normal operation, the DIM statement in line 5160 would be in the calling program, and the entry point to the plotting routine would be at line 5250. Line 5670 would also be changed from END to RETURN.

Lines 5250 through 5310 allow the user to enter the graph's title and legends for the X and Y axes. These strings are then centered in 50-character strings so they are printed at the center of the X and Y axes, independent of the title or legend length. Manual or automatic scaling can then be selected by answering the prompt in line 5320.

The main body (lines 5460 to 5670) and its subroutines are where the real plotting action occurs. Most dot-matrix printers print from the top of the page down and do not allow this top-down mode to be reversed. The MX-80 also fits into this category. The resulting limitation forces special handling of the data to be printed so that all the data of a given Y value is printed on a line before the next linefeed occurs. Once a linefeed is generated, there's no turning back to print another data point on the line above it.

In the main body, the first few lines set up the printer for 132 characters per line and 1/36 inch per linefeed. With these settings, a plot size of somewhat over 5½ inches in both directions is obtained when two linefeeds are performed for each of 101 data positions in the Y direction. Line 5520 performs a very important function in that it converts the line number position presently being pointed to on the plot to a numeric value proportionate to the total span of the data, which is set by the maximum and minimum scale values. (I didn't even understand that!) In other words, consider line number 100 to be at the top of the plot and line number 0 at the bottom; also suppose that $Y_{MAX}=1$ and $Y_{MIN}=-1$ as shown in figure 2. Then, if the present line number were 20 lines down from the top, the value of YN would be:

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Listing 1: *Program listing of MX-80 plotting routine, written in Microsoft MBASIC 5.*

```
5000 REM
5010 REM ***************************************************************
5020 REM *                   PLOT PROGRAM FOR MX-80                    *
5030 REM *                             BY                              *
5040 REM *                    LAWRENCE J. BREGOLI                      *
5050 REM ***************************************************************
5060 REM
5070 REM ***************************************************************
5080 REM *       USE THE FOLLOWING SPACE TO CALCULATE A 101 BY 101     *
5090 REM *       DATA ARRAY IN X(I) AND Y(I).                          *
5100 REM *       ENTER PROGRAM BELOW THIS SECTION IF ARRAY EXISTS      *
5110 REM ***************************************************************
5120 REM
5130 REM
5140 REM                                 SAMPLE ARRAY->CONCENTRIC CIRCLES
5150 REM
5160 DIM Y(101),X(101):REM               MOVE DIM TO MAIN PROGRAM
5170 FOR I=0 TO 50
5175 X(I)=SIN(I*6.282/50):Y(I)=COS(I*6.282/50)
5180 NEXT I
5185 FOR I=51 TO 100
5186 J=I-50
5187 X(I)=.5*SIN(J*6.282/50):Y(I)=.5*COS(J*6.282/50)
5190 NEXT I
5200 REM
5210 REM ***************************************************************
5220 REM *       ENTER TITLE OF PLOT AND AXIS LEGENDS                  *
5230 REM ***************************************************************
5240 REM
5250 XTITLE$=SPACE$(50):YTITLE$=SPACE$(50):PTITLE$=SPACE$(50)
5260 LINE INPUT "ENTER TITLE OF PLOT (50 CHARACTERS OR LESS) ";T$
5270 LINE INPUT "ENTER Y AXIS TITLE (50 CHARACTERS OR LESS) ";Y$
5280 LINE INPUT "ENTER X AXIS TITLE (50 CHARACTERS OR LESS) ";X$
5290 MID$(YTITLE$,(LEN(YTITLE$)-LEN(Y$))/2)=Y$
5300 MID$(XTITLE$,(LEN(XTITLE$)-LEN(X$))/2)=X$
5310 MID$(PTITLE$,(LEN(PTITLE$)-LEN(T$))/2)=T$
5320 INPUT "DO YOU WANT (A)UTO OR (M)ANUAL SCALING ";Y$
5330 IF Y$="M" THEN 5360
5340 IF Y$="A" THEN GOSUB 6550 ELSE 5320
5350 GOTO 5460
5360 INPUT "ENTER MAXIMUM VALUE OF Y AXIS";YMAX
5370 INPUT "ENTER MINIMUM VALUE OF Y AXIS";YMIN
5380 INPUT "ENTER MAXIMUM VALUE OF X AXIS";XMAX
5390 INPUT "ENTER MINIMUM VALUE OF X AXIS";XMIN
5400 REM
5410 REM ***************************************************************
5420 REM *         MAIN BODY OF PROGRAM STARTS HERE                    *
5430 REM ***************************************************************
5440 REM
5450 REM
5460 LPRINT:LPRINT:LPRINT TAB(15);PTITLE$:REM         PRINT TITLE OF PLOT
5470 LPRINT:LPRINT
5480 GOSUB 5810:REM                                   SET COMPRESSED CHAR MODE
5490 LSPACE=2:GOSUB 5780:REM                          SET LINE SPACING
5500 RSTOP=20:CHAR$="|":GOSUB 5850:REM                FORCE CARRIAGE LEFT
5510 FOR LNNO=100 TO 0 STEP -1
5520 YN=YMAX-(((YMAX-YMIN)/100)*(100-LNNO)):REM       NORMALIZED Y VALUE
5530 YD=ABS((YMAX-YMIN)/100):REM                      VALUE OF EACH LINE
5540 GOSUB 6250:REM                                   PRINT VERTICAL TITLE
5550 IF LNNO/2-FIX(LNNO/2)=0 THEN GOSUB 5910:REM      PLOT VERTICAL LINES
5560 GOSUB 6020:REM                                   PLOT DATA
5570 GOSUB 6140:REM                                   PRINT HORIZONTAL LINE
5580 LPRINT
5590 RSTOP=20:CHAR$="|":GOSUB 5850:REM                FORCE CARRIAGE LEFT
5600 LPRINT
5610 NEXT LNNO
5620 GOSUB 6350:REM                                   PRINT X SCALE
5630 GOSUB 6460:REM                                   PRINT X AXIS TITLE
5640 LSPACE=12:GOSUB 5780:REM                         SET NORMAL LINE SPACING
5650 GOSUB 5830:REM                                   SET NORMAL CHAR WIDTH
5660 FOR I=1 TO 23:LPRINT:NEXT I:REM                  TOP OF NEXT FORM
5670 END
5680 REM
5690 REM ****************************************************
5700 REM *      END OF MAIN BODY-SUBROUTINES START HERE     *
5710 REM ****************************************************
5720 REM
5730 REM
5740 REM ****************************************************
5750 REM *      PRINTER CONTROL SUBROUTINES                 *
5760 REM ****************************************************
5770 REM
5780 LPRINT CHR$(27)"A"CHR$(LSPACE)CHR$(27)"2":REM  EDIT WITH GRAFTRAX OPTION
5790 RETURN:REM                                       SET LINE SPACING
5800 REM
5810 LPRINT CHR$(15):RETURN:REM                       SET COMPRESSED MODE
5820 REM
5830 LPRINT CHR$(18):RETURN:REM                       SET NORMAL MODE
5840 REM
5850 LPRINT SPC(RSTOP);CHAR$;:RETURN:REM              PRINT CHAR AT RSTOP
5860 REM
5870 REM ****************************************************
5880 REM *     PLOT VERTICLE LINE SUBROUTINE                *
5890 REM ****************************************************
5900 REM
5910 CHAR$="|":RSTOP=20:LPRINT CHR$(13);:GOSUB 5850
5920 RSTOP=9
5930 FOR I=1 TO 10
```

Listing 1 continued on page 148

$$YN = 1-(((1-(-1))/100) \times (100 - 80)) = 0.6$$

This value is subsequently tested against the data in the PLOT DATA subroutine. If a match with any data in the Y array occurs, a point is plotted at the proper X position as determined by the value in the corresponding X array.

The overall action performed on any given line can be summed up as follows:

1. The value of YN is calculated.
2. A character in the Y-axis title is printed.
3. The vertical grid line segments are printed.
4. The data is plotted for that line, if any.
5. If a horizontal line is called for, it's printed along with the scale.
6. The cycle is repeated for the next line down.

A special precaution must be taken to ensure exact horizontal indexing on printers like the MX-80, as they use bidirectional printing. Because the print head doesn't physically return to the left-hand stop each time a new line is printed, a slight but distracting misalignment occurs in the vertical grid lines. To overcome this, lines 5500 and 5590 were inserted to force the print head to the left prior to each new line printed. If you take a close look at the left-hand vertical grid lines in figures 1 and 2, you can see this slight misalignment. If your particular printer is perfectly aligned or if you can put up with a slight misalignment error, then remove these line numbers. Removal of these lines will save a lot of time in actually plotting the data.

While I'm on the subject of time, it takes about eight minutes to complete a plot using the program shown in listing 1. This may seem a bit long to some users, but consider plotting 101 X,Y points by hand from a table of data. I'd rather sip my coffee and watch the MX-80 go about that agony. Later, I'll discuss a way to take about two minutes off this time.

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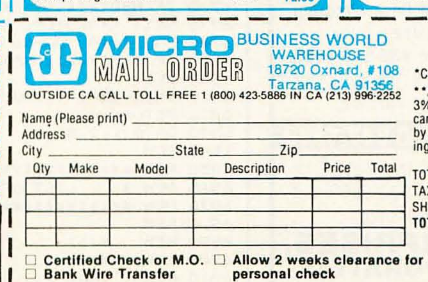
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Listing 1 continued:

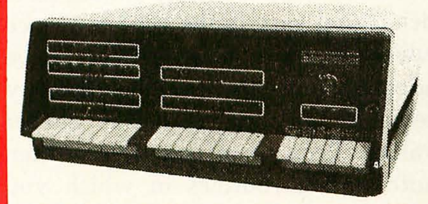
```
5940 GOSUB 5850
5950 NEXT I
5960 RETURN
5970 REM
5980 REM **************************************************
5990 REM *     PLOT DATA SUBROUTINE                        *
6000 REM **************************************************
6010 REM
6020 CHAR$="O"
6030 FOR I=0 TO 100
6040 IF (Y(I))>YN+.50001*YD OR (Y(I))<YN-.50001*YD THEN 6080
6050 XP=FIX((X(I)-XMIN)*100/(XMAX-XMIN))
6060 IF XP<0 OR XP>100 THEN 6080
6070 LPRINT CHR$(13);:RSTOP=XP+20:GOSUB 5850
6080 NEXT I:RETURN
6090 REM
6100 REM **************************************************
6110 REM *     PLOT Y SCALE AND HORIZONTAL LINE SUBROUTINE *
6120 REM **************************************************
6130 REM
6140 IF LNNO/10-FIX(LNNO/10)<>0 THEN RETURN
6150 LPRINT CHR$(13);:RSTOP=10:CHAR$="":GOSUB 5850
6160 LPRINT USING "######.##";(YMAX-YMIN)*LNNO/100+YMIN;
6170 LPRINT CHR$(13);:RSTOP=20:CHAR$="-":GOSUB 5850
6180 LPRINT STRING$(100,"-");
6190 RETURN
6200 REM
6210 REM **************************************************
6220 REM *     PRINT YAXIS TITLE                           *
6230 REM **************************************************
6240 REM
6250 IF LNNO/2-FIX(LNNO/2)<>0 THEN RETURN
6260 LPRINT CHR$(13);:RSTOP=7
6270 CHAR$=MID$(YTITLE$,FIX(((100-LNNO)/2)+1),1)
6280 GOSUB 5850
6290 RETURN
6300 REM
6310 REM **************************************************
6320 REM *    PRINT X SCALE SUBROUTINE                     *
6330 REM **************************************************
6340 REM
6350 LPRINT:LPRINT
6360 RSTOP=13:CHAR$="":GOSUB 5850
6370 FOR I=0 TO 10
6380 LPRINT USING "#######.##";(XMAX-XMIN)*I/10+XMIN;
6390 NEXT I
6400 RETURN
6410 REM
6420 REM **************************************************
6430 REM *     PRINT X AXIS TITLE                          *
6440 REM **************************************************
6450 REM
6460 LPRINT:LPRINT:LPRINT
6470 LPRINT:LPRINT:LPRINT
6480 RSTOP=45:CHAR$=XTITLE$:GOSUB 5850
6490 RETURN
6500 REM
6510 REM **************************************************
6520 REM *        AUTO SCALING SUBROUTINES                 *
6530 REM **************************************************
6540 REM
6550 YMAX=Y(0):XMAX=X(0):YMIN=Y(0):XMIN=X(0)
6560 FOR I=1 TO 100:REM                             FIND XMAX & YMAX
6570 IF Y(I)>YMAX THEN YMAX=Y(I)
6580 IF Y(I)<YMIN THEN YMIN=Y(I)
6590 IF X(I)>XMAX THEN XMAX=X(I)
6600 IF X(I)<XMIN THEN XMIN=X(I)
6610 NEXT I
6620 RESTORE 6830:REM-----------------------------------------------------
6630 MSD=(YMAX-YMIN)/10:REM                         SCALE THE Y AXIS
6640 FOR I=-2 TO 4
6650 FOR K=1 TO 3:READ J
6660 IF MSD<=J*10^(I) THEN MSD=J*10^(I):GOTO 6680
6670 NEXT K:RESTORE 6830:NEXT I
6680 FOR I=10 TO -10 STEP -1
6690 IF (YMAX<=I*MSD)*(YMAX>I*MSD-.99999*MSD) THEN YMAX=I*MSD
6700 NEXT I
6710 YMIN=YMAX-10*MSD
6720 RESTORE 6830:REM-----------------------------------------------------
6730 MSD=(XMAX-XMIN)/10:REM                         SCALE THE X AXIS
6740 FOR I=-2 TO 4
6750 FOR K=1 TO 3:READ J
6760 IF MSD<=J*10^(I) THEN MSD=J*10^(I):GOTO 6780
6770 NEXT K:RESTORE 6830:NEXT I
6780 FOR I=10 TO -10 STEP-1
6790 IF (XMAX<=I*MSD)*(XMAX>I*MSD-.99999*MSD) THEN XMAX=I*MSD
6800 NEXT I
6810 XMIN=XMAX-10*MSD
6820 RETURN
6830 DATA 1,2,5
6840 REM
6850 REM **************************************************
6860 REM *     LIST OF VARIABLE NAMES USED IN PROGRAM      *
6870 REM **************************************************
6880 REM
6890 REM    Y(I)                 Y AXIS DATA ARRAY
6900 REM    X(I)                 X AXIS DATA ARRAY
6910 REM    YMAX                 MAXIMUM VALUE OF Y AXIS
6920 REM    YMIN                 MINIMUM   "   "  "  "
```

Listing 1 continued on page 150

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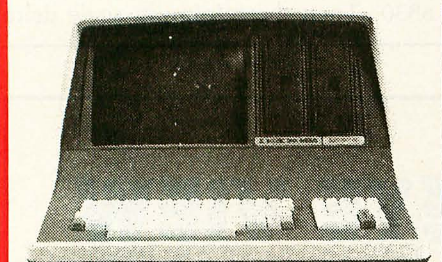
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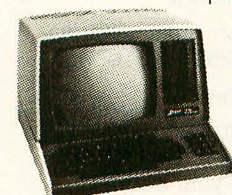
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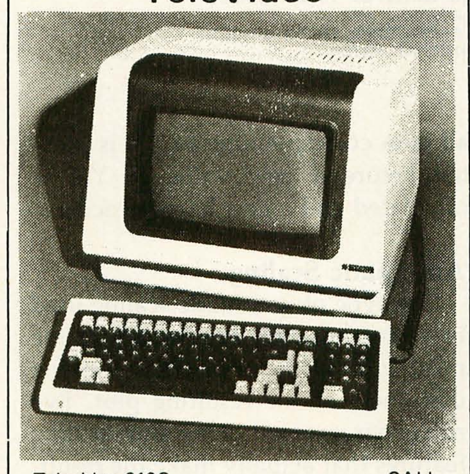
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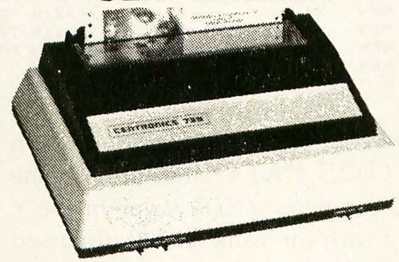
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Listing 1 continued:

```
6930 REM   XMAX                  MAXIMUM VALUE OF X AXIS
6940 REM   XMIN                  MININUM   "    "   "
6950 REM   LNNO                  Y AXIS LINE NUMBER
6960 REM   RSTOP                 CHARACTER TAB STOP
6970 REM   LSPACE                SIZE OF LINEFEED AT PRINTER
6980 REM   YN                    NORMALIZED Y AXIS VALUE
6990 REM   YD                    DELTA VALUE FOR EACH Y AXIS LINE
7000 REM   XP                    CHARACTER POSITION ON X AXIS
7010 REM   MSD                   MINIMUM SCALE DELTA
7020 REM   J                     SCALE DELTA
7030 REM   K                     INDEX COUNTER
7040 REM   I                     INDEX COUNTER
7050 REM   T$                    PLOT TITLE
7060 REM   PTITLE$               PLOT TITLE CENTERED IN 50 SPACES
7070 REM   Y$                    Y AXIS TITLE
7080 REM   YTITLE$               Y AXIS TITLE CENTERED IN 50 SPACES
7090 REM   X$                    X AXIS TITLE
7100 REM   XTITLE$               X AXIS TITLE CENTERED IN 50 SPACES
7110 REM   CHAR$                 STRING PRINTED AT RSTOP
7120 REM
```

may be difficult to interpret occurs in the PLOT DATA subroutine. Line 6040 compares a data value in the Y array with the value of YN discussed above. If the value in the Y array equals YN plus or minus 51 percent of the value between lines, it's printed on the plot at an X position determined by the corresponding value in the X array. This value (XP) is calculated in line 6050. The PLOT DATA subroutine checks every data value in the Y array each time the subroutine is called to make sure that all data corresponding to YN is plotted before a new value of YN is calculated and a new linefeed occurs.

Automatic Scaling

The type of automatic scaling used in a plot program can be one of the most critical factors in determining usefulness of the resulting plot. I've run programs containing auto-scaling features that actually make the resulting plot worthless. These programs seem to be written so that the highest data point falls on the top line and the lowest falls on the bottom line—without any consideration of the intermediate scale values. This type of scaling is the easiest to implement but makes data interpretation extremely difficult. One of the problems in developing auto-scaling routines involves individual perference regarding the scales selected. Some people may prefer the type of scaling mentioned above, some may choose scale deltas that vary in the 1-2-5 sequence which many analog plotters have adopted, and others may accept any sequence as long as it has integer values. Because of this, I've written auto-scaling routines in which you can tailor the scaling sequence simply by inserting a new DATA statement with user-selected values.

The auto-scaling subroutines start at line 6550. The extreme values in both the X and Y arrays are determined in lines 6550 through 6610; then the X and Y scales are determined. Determination of the scales starts by restoring the DATA statement in 6830. Then the minimum scale delta

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Listing 2: *Additional software to presort data prior to plotting.*

```
5450 REM
5452 REM **************************************************
5454 REM *   SPEED UP MODIFICATIONS USING SORT ROUTINE     *
5456 REM **************************************************
5458 REM
5465 TOP=100:TEMPTOP=100
5468 GOSUB 6890:REM                                SORT DATA
5970 REM
5980 REM **************************************************
5990 REM *   PLOT SORTED DATA SUBROUTINE                   *
6000 REM **************************************************
6010 REM
6020 CHAR$="O"
6030 FOR I=TOP TO 0 STEP -1
6033 IF Y(I)>YN+.50001*YD THEN 6080
6035 IF Y(I)<YN-.5*YD THEN I=0:GOTO 6080
6040 TEMPTOP=I
6050 XP=FIX((X(I)-XMIN)*100/(XMAX-XMIN))
6060 IF XP<0 OR XP>100 THEN 6080
6070 LPRINT CHR$(13);:RSTOP=XP+20:GOSUB 5850
6080 NEXT I:TOP=TEMPTOP:RETURN
6840 REM
6850 REM **************************************************
6860 REM *         SHELL SORT OF DATA                      *
6870 REM **************************************************
6880 REM
6890 M=100
6910 M=INT(M/2):IF M=0 THEN RETURN
6920 J=0:K=100-M
6930 I=J
6940 L=I+M:IF Y(I)<Y(L) THEN 6970
6950 T=Y(I):T1=X(I):Y(I)=Y(L):X(I)=X(L):Y(L)=T:X(L)=T1:I=I-M
6960 IF I<0 THEN 6970 ELSE 6940
6970 J=J+1:IF J<=K THEN 6930 ELSE 6910
6980 REM
```

(MSD) is determined, based on the data extremes. This value is the smallest that can be used between major scale divisions yet still fit all the data on a plot with ten major divisions. Line 6640 starts a FOR. . .NEXT loop which selects the multiplier for the scale divisions; the nested FOR. . .NEXT loop beginning at line 6650 selects the value of the major scale divisions using the DATA statement in line 6830. Lines 6660 through 6710 then use this information to determine new maximum and minimum scale values which in turn are used in the data plotting routines. Scaling of both the X and Y axes is handled in the same manner.

Although the logic of these routines would become quite clear with some study, you don't have to understand these routines at all to select your own personalized auto-scaling factors. Simply change the DATA statement in line 6830 and the limit of the FOR. . .NEXT loops in lines 6650 and 6750. For example, suppose you like any even integer scaling. Change the DATA statement from 1, 2, 5 to 1, 2, 3, 4, 5, 6, 7, 8, 9, and change the upper limits in the READ loops from 3 to 9. I don't like scales with increments of 3, 6, 7, 8, or 9 and typically use a scaling of 1, 2, 2.5, 4, 5. As I've stated, though, this depends strictly on your esthetic values. The program uses 1, 2, 5 scaling as an example.

Figure 3 is a plot of EXP(X) versus X using 1, 2, 2.5, 4, 5 auto-scaling values. Exponential curves such as

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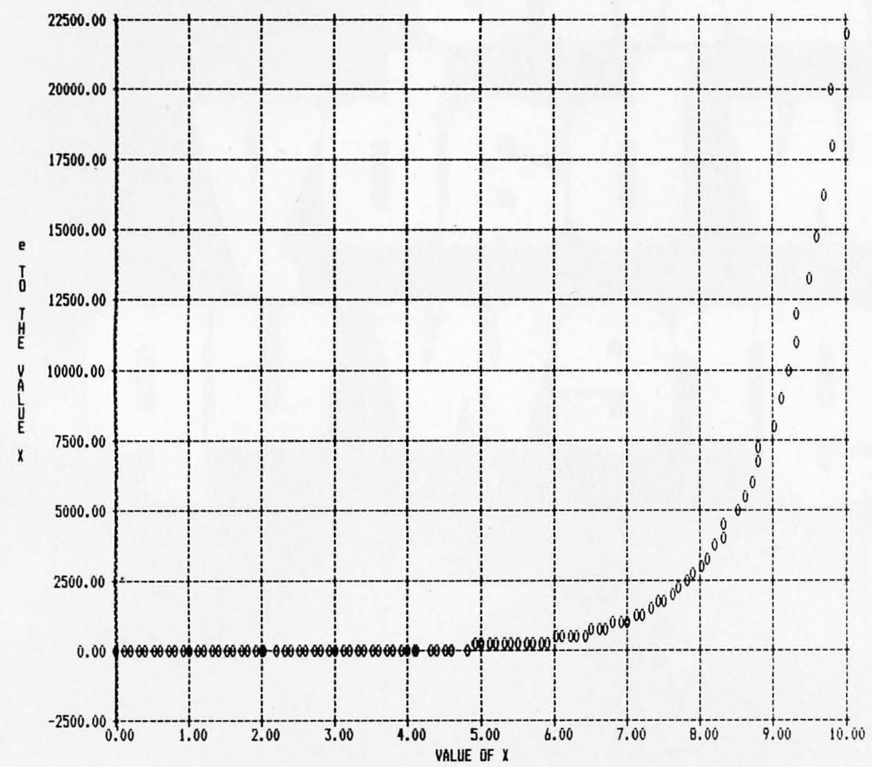
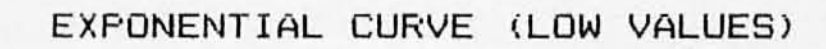


Figure 3: *Sample plot of exponential curve using auto-scaling (Y=EXP(X)).*



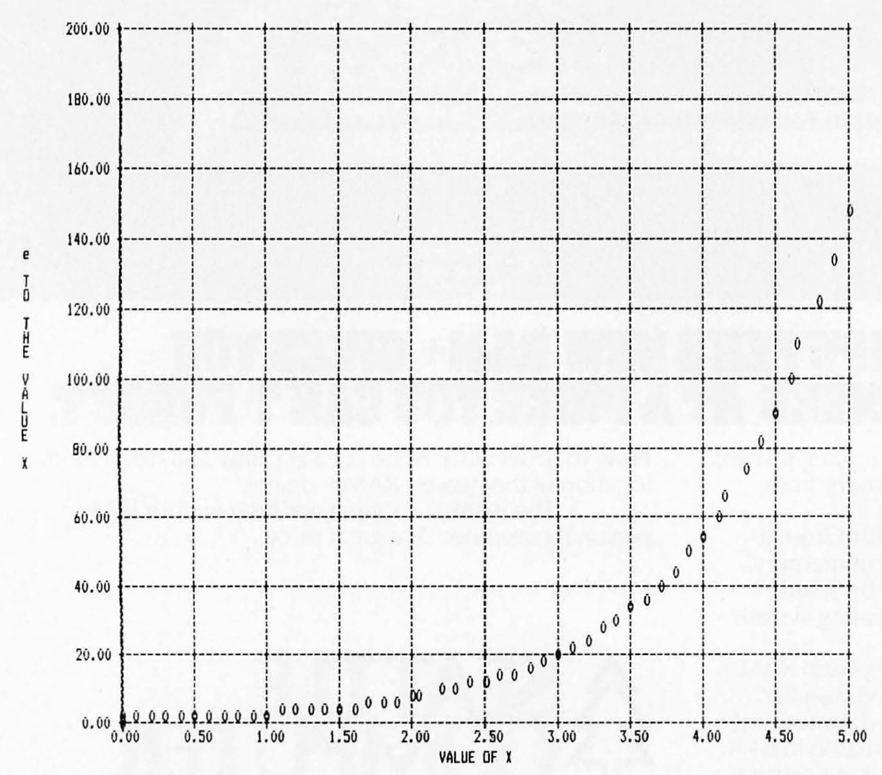


Figure 4: *Sample plot of exponential curve using manual scaling (expanded section of figure 3).*

the one shown are particularly difficult for any linear plot routine to handle because of the wide range of values usually involved. It's obvious from figure 3 that much of the data falls below the Y value of 200 and below the X value of 5. With this type of data, it's sometimes desirable to have a higher-resolution plot of this section of the data. You can accomplish that by now replotting this section of data using the MANUAL feature of the program. Figure 4 shows a plot of the same data with the Y scale manually set from 0 to 200 and with the X scale manually set from 0 to 5. Use of auto-scaling to present all of the data and manual scaling to expand features of the overall plot can provide a very powerful tool for those who have to handle data regularly.

Speeding It Up

As I mentioned before, this plotting routine isn't very fast and has never been optimized to make it faster. One obvious method to decrease the overall time is to presort the data prior to plotting it so that the PLOT DATA routine doesn't have to scan every bit of data each time through. Listing 2 shows the lines that have to be added or modified to sort and plot the data with the sort routine given. Inserting these lines will cut almost two minutes off each plot, but there's no free lunch here either. What price is paid for this speed-up feature? The data isn't the same as when it entered the routine, since the array numbers have been altered. You could save the arrays in other arrays to maintain the integrity of your data, but this will cost you variable space. Again, use of these options is strictly up to the user and the particular application.

I've written the software for a standard MX-80 *without* the Graftrax-80 option. Those of you having this option should delete the last part of line 5780, since the CHR$(27)"2" is no longer needed.

Please feel free to write and let me know of any features of the MX-80 or of the program I've missed that would reduce the plot time—my mailman will love it! ■



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The various Paper Tiger models produced by Integral Data Systems (IDS) are popular with microcomputer owners because they're rugged, reliable, extremely flexible in operation, and well supported by the manufacturer. That tremendous flexibility, however, is marred by one "bug" in the IDS 460. I use my high-speed printer to generate business reports (using both single- and multiple-part copy paper), form letters, and address labels. This necessitates a change from thick address labels to thin fanfold paper to single sheets in holders to carbonless multiple-part copy-forms, and back again.

The paper-thickness control knob is located *inside* the cover. In order to adjust it, you must remove the cover, adjust the control, replace the cover (try not to snag the ribbon or damage the circuit board), and then run the printer to see if it's adjusted correctly. If it isn't, you have to start all over again.

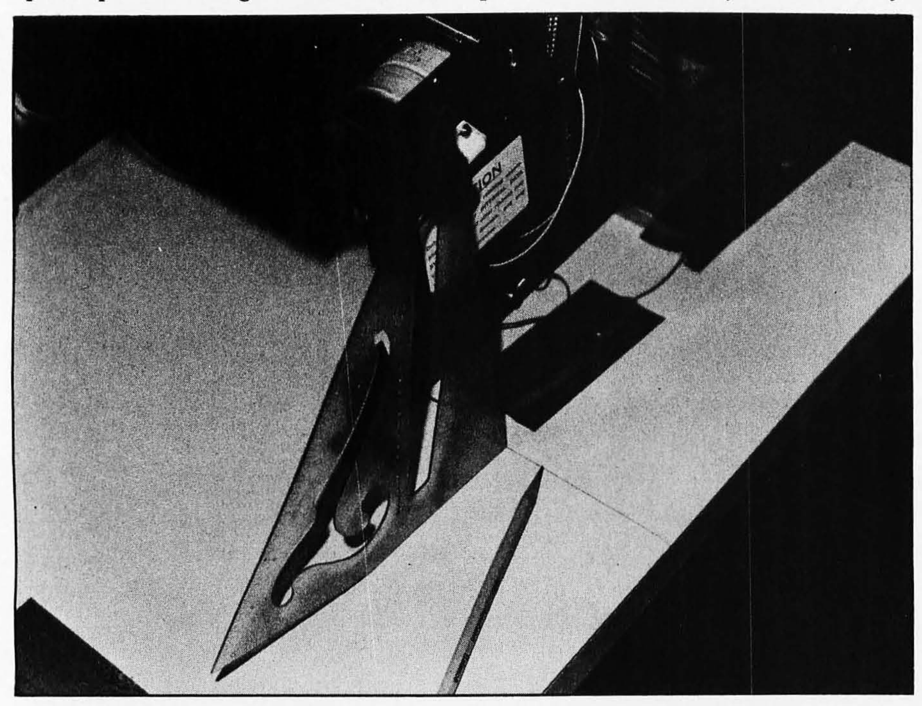


Photo 1: *Use a square or a drafting triangle to mark the table directly beneath the center of the knob. Measure the height of the shaft above the table and mark the triangle.*

A simple modification solves this problem, making it easy to adjust to the proper paper thickness from *outside* the printer. All you have to do is drill a hole in the cover and cut a slot in the adjusting rod for a screwdriver.

(Editor's Note: *IDS says that this modification isn't necessary for the newest version of the model 460, as there is a lever attached to the paper-thickness control knob which allows it to be adjusted from outside the printer. You can purchase this lever and knob by contacting Customer Support Group, Integral Data Systems Inc., Milford, NH 03055. If you choose to make the modifications described in this article, IDS says it will still repair its printers no longer under warranty, as long as the printer mechanism itself has not been modified....* **SJW)**

The first step is to locate the position for the hole. Put the printer on a light-colored table or piece of paper and remove the cover. Set a drafting triangle or a small carpenter's square on the table (see photo 1) and make a mark on the table or paper directly below the center of the paper-thickness control knob. Then mark on the triangle the height of the center of the control knob from the table. Without moving the printer, carefully replace the cover. Using the marks on the table and on the triangle, find the spot on the cover where the two marks intersect (see photo 2). Mark

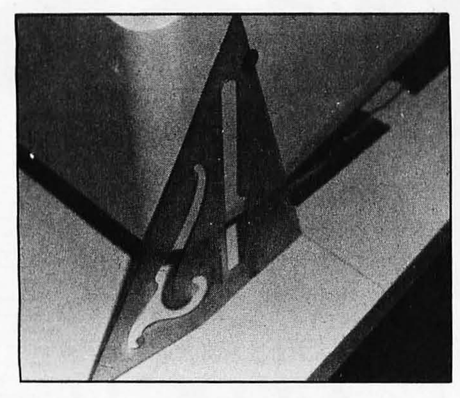


Photo 2: *After replacing the cover, use the square to mark the hole location on the cover.*



Photo 3: *Slotting the end of the thickness-adjusting knob allows it to be adjusted with a screwdriver.*

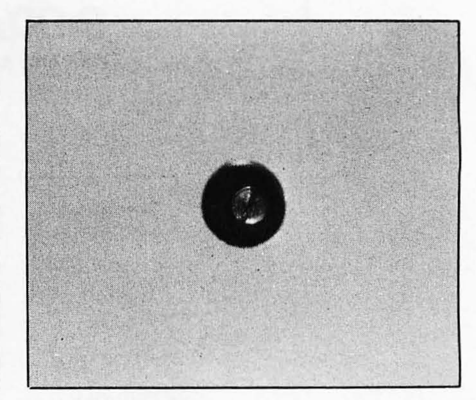


Photo 4: *The hole in the cover opposite the paper-thickness adjusting knob allows easy access with a screwdriver.*

this spot on the cover. This is the location for the hole you will drill.

Next, remove the cover from the printer. As you begin to drill the hole, let the drill bit turn slowly (I used a sharp ⅝-inch drill and a drill press for an accurate hole). Make the hole large enough to allow a screwdriver to be inserted easily.

Use a fine-tooth hacksaw to cut a slot in the shaft (see photo 3), and watch out for the circuit board and the wires attached to it. I chose to make a slot that is horizontal when the print head is at its closest setting so that I could use it as a reference point. Once the shaft was marked, however, I turned it 45 degrees clockwise to cut it, making it less awkward to work on. Saw through the knob and the shaft until you have a screwdriver slot about $\frac{1}{16}$-inch deep. Then clean out all the shavings from the printer.

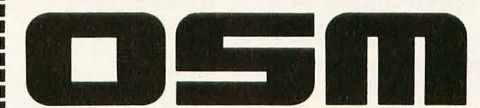
Replace the cover, erase any pencil marks, and adjust your printer from the outside (see photo 4). I find that the screwdriver blade on my jackknife fits perfectly. It's easy to set the proper adjustment while the Paper Tiger is printing its test pattern on the type of paper you will be using. I also marked the positions of the slot for various paper thicknesses on the cover of the printer, so that I can quickly set the different adjustments.■

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BASIC Formatted Printing

Dr. Malladi Subbaiah
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How often would you like to have the results of a computation printed in a selected format? Unlike FORTRAN or Extended BASIC, a minimal BASIC such as TI BASIC does not usually have FORMAT statements. Listing 1 shows a routine that I developed to obtain printer output in any desired format with my BASIC programs. The routine, written in TI BASIC (although it can easily be adapted to other BASICs), is simple to use because the PRINT statement can directly access the user-defined format functions without any conditional transfers.

To use the format routine in a program, you must include the statements in lines 230 through 320 in your program before the first PRINT statement. Line 510 is a typical example of such a PRINT statement. Titles and string variables are printed using a PRINT statement like that shown in line 490.

An example of the formatted output is shown in figure 1b. The results would have been printed as in figure 1a if a regular PRINT statement with semicolon print separators (line 470) was used. (Figures 1a and 1b are on page 164.)

The formatting routine takes advantage of the string variables used in TI BASIC. To print a real variable, say X, print the formatted string RF$(X). Similarly, use IF$(I) to print an integer, I. To obtain print titles, use RFT$(X$) to print X$ as the title associated with the real numbers. IFT$(I$) is a similar function for titles of integer fields. RFT$(X$) and IFT$(I$) can, of course, be used like RF$ and IF$ to print any string variables.

The format field is controlled by the variables FL, FD, and IL (see the DATA statement on line 250). FL and IL represent the total length of the field for real and integer variables, and FD is the number of decimal places chosen for the real numbers. The real numbers are rounded off to the desired digits. (The effect of the two format descriptions is similar to using the FORTRAN statements FORMAT(F FL.FD) for real numbers and FORMAT (I IL) for the integer numbers.)

The program prints right-justified entries in the user-selected field in both real and integer formats. When the value of the variable is larger than can be accommodated in the allocated field, a starred output is printed as shown in figure 1b.■

Listing 1: *The format routine embedded in this program (lines 230 through 320) allows control of printer output without the use of FORMAT statements.*

```
100 REM  FORMAT PRINTING
110 REM   IN TI BASIC
120 REM
130 REM  PROGRAM BY
140 REM  MALLADI SUBBAIAH
150 REM
160 REM  FL- PRINT LENGTH
170 REM   FOR REAL NOS.
180 REM  FD- DECIMAL DIGITS
190 REM  IL- PRINT LENGTH
200 REM   FOR INTEGER NOS.
210 REM  *****************
220 REM
230 RESTORE 250
240 READ FL,FD,IL
250 DATA 10,3,6
255 FLD=FL-FD-1
260 BLNK$="             "
262 STAR$=" ***********"
264 DEF C1(X)=INT(((ABS(X)>10^FLD)+(ABS(X)>1E10)-1)/-2)
266 DEF C2(I)=INT(((ABS(I)>10^IL)+(ABS(I)>1E10)-1)/-2)
270 DEF RX$(X)=STR$(X+SGN(X+1E-40)*0.5/10^FD)
295 DEF RF$(X)=SEG$(STAR$&BLNK$&RX$(X),1+(24-FL+POS(RX$(X),".",1)+FD)*(1-C1(X)),
FL)
305 DEF IF$(I)=SEG$(STAR$&BLNK$&STR$(I),1+(24-IL+LEN(STR$(I)))*(1-C2(I)),IL)
310 DEF RFT$(X$)=SEG$(BLNK$&X$&BLNK$,LEN(BLNK$)-(FL-FD-1-LEN(X$)/2),FL)
320 DEF IFT$(I$)=SEG$(BLNK$&I$,LEN(BLNK$)-IL+LEN(I$)+1,IL)
330 REM
340 REM   *****************
350 REM  END FORMAT ROUTINE
360 REM
370 DIM M(10),X(10),Y(10),XY(10)
380 READ M(1),M(2),M(3),M(4),M(5),M(6),M(7),M(8),M(9),M(10)
390 READ X(1),X(2),X(3),X(4),X(5),X(6),X(7),X(8),X(9),X(10)
400 READ Y(1),Y(2),Y(3),Y(4),Y(5),Y(6),Y(7),Y(8),Y(9),Y(10)
410 DATA 12,-25,1E12,167,-5,432,29,7618219,14,9527
420 DATA -1.7962,23.95,4741.111111,1E21,1E-14,-0.0265,79830.90145,134.91672,245.
92135,216.9821
430 DATA -2.1,0.97,1.86372,0.01754,7.8924,6.9159,1.15,3.000145,176.36241,213.567
434 N=10
435 U=1
440 OPEN #1:"RS232"
450 FOR I=1 TO N
460 XY(I)=X(I)*Y(I)
470 PRINT #U::I;M(I);X(I);Y(I);XY(I)
480 NEXT I
490 PRINT #U:::IFT$("I");IFT$("M(I)");RFT$("X(I)");RFT$("Y(I)");RFT$("X(I)*Y(I)
")::
500 FOR I=1 TO N
510 PRINT #U:IF$(I);IF$(M(I));RF$(X(I));RF$(Y(I));RF$(XY(I))
520 NEXT I
530 CLOSE #1
540 STOP
```

Esprit™

has a timely announcement on buyer protection for only $49.95.

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Telegram western union

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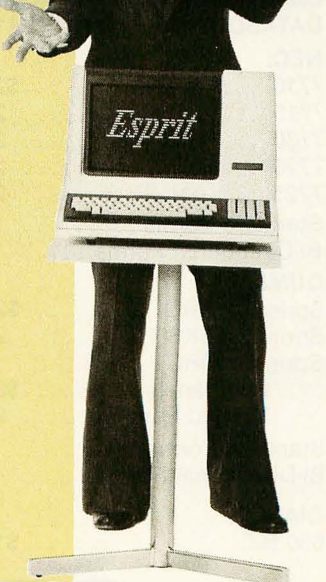
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Circle 177 on inquiry card.

```
1  12 -1.7962 -2.1  3.77202

2 -25  23.95  .97  23.2315

3  1.E+12  4741.111111  1.86372  8836.1036

4  167  1.E+21  .01754  1.754E+19

5 -5  1.E-14  7.8924  7.8924E-14

6  432 -.0265  6.9159 -.18327135

7  29  79830.90145  1.15  91805.53667

8  7618219  134.91672  3.000145  404.7697229

9  14  245.92135  176.36241  43371.28196

10  9527  216.9821  213.567  46340.21615
```

Figure 1a: *Sample of printer output from the program in listing 1 without the format routine.*

```
I  M(I)      X(I)      Y(I)   X(I)*Y(I

1     12    -1.796    -2.100     3.772
2    -25    23.950      .970    23.232
3  *****  4741.111     1.864  8836.104
4    167 *********      .018 *********
5     -5      .000     7.892      .000
6    432     -.027     6.916     -.183
7     29 79830.901     1.150 91805.537
8  *****   134.917     3.000   404.770
9     14   245.921   176.362 43371.282
10  9527   216.982   213.567 46340.216
```

Figure 1b: *Using the format routine, the printer output can be formatted to suit your needs. If a number exceeds the length available for a variable, the program in listing 1 will print a string of stars, as shown in lines 3, 4, and 8.*

Epson MX-80 Print-Control Program for the Apple II

Bill Starbuck
2100 East Edgewood Ave.
Shorewood, WI 53211

How many times have you, after buying a new "toy" for your computer, installed the hardware, read the manual carefully, and played with the equipment until its functions become familiar, only to go back to your regular activities and forget much of what you've learned?

This is what happened after I bought my Epson MX-80 printer. I studied the manual conscientiously and learned all the printer-control codes. For weeks thereafter, I did nothing with the printer except turn it on and off. By the time my Epson Graftrax-80 bit-plot graphics option arrived, I had forgotten how the printer worked.

This time I entrusted the information to the Apple's memory instead of my own. I wrote a print-control program in Applesoft BASIC, called MX-80 (see listing 1), that I keep on disk with my Applewriter text editor.

When the program is run, the screen displays a menu of available printer options (see figure 1). The on-screen display has some of the instruction codes highlighted as black on white. The highlighted options are the choices transmitted to the printer when one of the three termination codes (EDITOR, PRINTER, or QUIT) is entered. To review the inventory of (nongraphics) printer signals, I can choose the INVENT option.

There is no way to query the printer about its current status, so the program records a status file, called MX.STATUS, that recalls the last instructions sent to the printer. This status file is used to initialize the program the next time it is run. The status file is especially convenient when a given typeface is used repeatedly. So that there will be a file for the print-control program to read

Text continued on page 170

```
STANDARD = STANDARD FONT
ITALIC   = ITALIC FONT

STRIKE1  = SINGLE STRIKE
STRIKE2V = TWO VERTICAL STRIKES
STRIKE2H = TWO HORIZONTAL STRIKES*
STRIKE4  = QUADRUPLE STRIKES*
               * ONLY WITH NORMAL LETTERS

SMALL    = SMALL LETTERS, UP TO 132/LINE
NORMAL   = NORMAL LETTERS, UP TO 80/LINE

SPACEN   = NORMAL SPACING BETWEEN LINES
SPACET   = TIGHT SPACING BETWEEN LINES
SPACE0   = NO SPACE BETWEEN LINES

INVENT   = INVENTORY OF MX-80 SIGNALS

EDITOR   = SHIFT TO APPLEWRITER'S EDITOR
PRINTER  = SHIFT TO APPLEWRITER'S PRINTER
QUIT     = QUIT

ENTER INSTRUCTION CODE:
```

Figure 1: *Menu from the MX-80 print-control program. The menu offers 36 combinations: 24 with normal letters (two fonts by four strikes by three spacings); 12 with small letters (two fonts by two strikes by three spacings). You can also choose INVENT, an inventory of the control signals for the Graftrax-80 function codes, and one of three program-termination options—EDITOR, PRINTER, and QUIT.*

TRS-80* COMPUTING EDITION

©1981 Percom Data Co., Inc. **The Percom Peripheral** 35 cents

Percom's DOUBLER II™ tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double-density plug-in module for TRS-80* Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II™, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

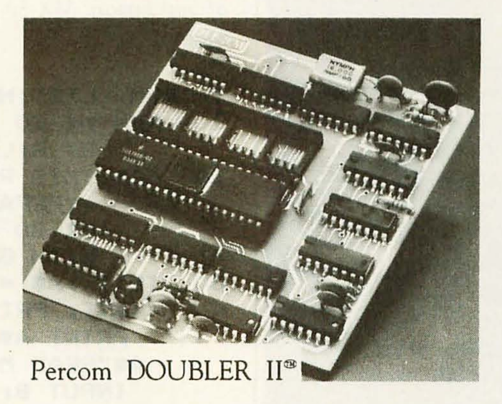
With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(*Ed. Note:* See "OS-80™: Bridging the TRS-80* software compatibility gap" elsewhere on this page.)

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design *called a ROM-programmed digital phase-lock loop data separator*.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides *immunity to performance degradation caused by circuit component aging*.



Percom DOUBLER II™

Mauch said "A DOUBLER II will operate just as reliably two years after it is installed as it will two days after installation."

The digital phase-lock loop also *eliminates the need for trimmer adjustments typical of analog phase-lock loop circuits*.

"You plug in a Percom DOUBLER II and then forget it," he said.

The DOUBLER II also features a refined Write Precompensation circuit that more effectively minimizes the phenomena of bit- and peak-shifting, a reliability-impairing characteristic of magnetic data recording.

The DOUBLER II, which is fully software compatible with the previous DOUBLER, is supplied with DBLDOS™, a TRSDOS*-compatible disk operating system.

The DOUBLER II sells for ~~$219.95~~, including the DBLDOS diskette. NOW $169.95!

The Percom DOUBLER II is available from authorized Percom retailers, or may be ordered direct from the factory. The factory toll-free order number is 1-800-527-1222.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 309 on inquiry card.

Circuit misapplication causes diskette read, format problems.

High resolution key to reliable data separation

GARLAND, TEXAS — The Percom SEPARATOR™ does very well for the Radio Shack TRS-80* Model I computer what the Tandy disk controller does poorly at best: *reliably* separates clock and data signals during disk-read operations.

Unreliable data-clock separation causes format verification failures and repeated read retries.

CRC ERROR–TRACK LOCKED OUT

The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the clock-data separation problem was traced by Percom to misapplication of the internal separator of the 1771 drive controller IC used in the Model I.

The Percom Separator substitutes a *high-resolution* digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

Separator circuits that operate at lower frequencies — for example, two- or four-megahertz — were found by Percom to provide only marginally improved performance over the original Tandy circuit.

The Percom solution is a simple adapter that plugs into the drive controller of the Expansion Interface (EI).

Not a kit — some vendors supply an untested separator kit of resistors, ICs and other paraphernalia that may be installed by modifying the computer — the Percom SEPARATOR is a fully assembled, fully tested plug-in module.

Installation involves merely plugging the SEPARATOR into the Model I EI disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only $29.95, may be purchased from authorized Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1222.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 308 on inquiry card.

All that glitters is not gold

OS-80™ Bridging the TRS-80* software compatibility gap

Compatibility between TRS-80* Model I diskettes and the new Model III is about as genuine as a gold-plated lead Krugerrand.

True, Model I TRSDOS* diskettes can be *read* on a Model III. But first they must be converted and re-recorded for Model III operation.

And you *cannot write* to a Model I TRSDOS* diskette. Not with a Model III. You cannot add a file. Delete a file. Or in any way modify a Model I TRSDOS diskette with a Model III computer.

Furthermore, your converted TRSDOS diskettes cannot be converted *back* for Model I operation.

TRSDOS is a one-way street. And there's no retreating. A point to consider before switching the company's payroll to your new Model III.

Real software compatibility should allow the *direct, immediate* interchangeability of Model I and Model III diskettes. No read-only limitations, no conversion/re-recording steps and no chance to be left high and dry with Model III diskettes that can't be run on a Model I.

What's the answer? The answer is Percom's OS-80™ family of TRS-80 disk operating systems.

OS-80 programs allow *direct, immediate* interchangeability of Model I and Model III diskettes.

You can run Model I single-density diskettes on a Model III; install Percom's plug-in DOUBLER™ adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There's no conversion, no re-recording.

Slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa.

Just have the correct OS-80 disk operating system — OS-80, OS-80D or OS-80/III — in each computer.

Moreover, with OS-80 systems, you can add, delete, and update files. You can read *and write* diskettes regardless of the system of origin.

OS-80 is the original Percom TRS-80 DOS for BASIC programmers.

Even OS-80 utilities are written in BASIC.

OS-80 is the Percom system about which a user wrote, in Creative Computing magazine, "...the best $30.00 you will ever spend."†

Requiring only seven Kbytes of memory, OS-80 disk operating systems reside completely in RAM. There's no need to dedicate a drive exclusively for a system diskette.

And, unlike TRSDOS, you *can* work at the track sector level, defining and controlling data formats — in BASIC — to create simple or complex data structures that execute more quickly than TRSDOS files.

The Percom OS-80 DOS supports single-density operation of the Model I computer — price is $29.95; the OS-80D supports double-density operation of Model I computers equipped with a DOUBLER or DOUBLER II; and, OS-80/III — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80/III each sell for $49.95. Circle 310 on inquiry card.

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™Trademark of Percom Data Company, Inc. *TRS-80 and TRSDOS are trademarks of Tandy Corporation which has no relationship to Percom Data Company. †Creative Computing Magazine, June, 1980, page 26.



Listing 1: *MX-80, an Applesoft program that controls the print of an Epson MX-80 printer equipped with the Graftrax-80 option.*

```
1  REM  LISTING 1:
10  REM MX-80
        BY BILL STARBUCK
20  REM THIS PROGRAM SETS THE
        TYPEFACES OF THE EPSON
        MX-80 PRINTER EQUIPPED
        WITH GRAFTRAX-80.
30  TEXT :A$ =  CHR$ (4):D$ =  CHR$
     (27): PRINT A$"NOMON C,I,O":
     PRINT A$"OPEN MX.STATUS": PRINT
    A$"READ MX.STATUS": INPUT A:
     INPUT B: INPUT C: INPUT D: PRINT
    A$"CLOSE MX.STATUS"
40  PRINT A$"PR# 0": HOME : IF A =
    1 THEN  INVERSE
50  PRINT "STANDARD";: NORMAL : PRINT
    " = STANDARD FONT": IF A = 2
     THEN  INVERSE
60  PRINT "ITALIC";: NORMAL : PRINT
    "     = ITALIC FONT": PRINT : IF
    B = 1 THEN  INVERSE
70  PRINT "STRIKE1";: NORMAL : PRINT
    "    = SINGLE STRIKE": IF B =
    2 THEN  INVERSE
80  PRINT "STRIKE2V";: NORMAL : PRINT
    " = TWO VERTICAL STRIKES": IF
    B = 3 THEN  INVERSE
90  PRINT "STRIKE2H";: NORMAL : PRINT
    " = TWO HORIZONTAL STRIKES*"
    : IF B = 4 THEN  INVERSE
100  PRINT "STRIKE4";: NORMAL : PRINT
    "    = QUADRUPLE STRIKES*": PRINT
     TAB( 15)"* ONLY WITH NORMAL
     LETTERS": IF C = 1 THEN  INVERSE

110  PRINT "SMALL";: NORMAL : PRINT
     "     = SMALL LETTERS, UP TO 1
     32/LINE": IF C = 2 THEN  INVERSE

120  PRINT "NORMAL";: NORMAL : PRINT
     "    = NORMAL LETTERS, UP TO 8
     0/LINE": PRINT : IF D = 1 THEN
      INVERSE
130  PRINT "SPACEN";: NORMAL : PRINT
     "    = NORMAL SPACING BETWEEN
     LINES": IF D = 2 THEN  INVERSE

140  PRINT "SPACET";: NORMAL : PRINT
     "    = TIGHT SPACING BETWEEN L
     INES": IF D = 3 THEN  INVERSE

150  PRINT "SPACEO";: NORMAL : PRINT
     "  = NO SPACE BETWEEN LINES"
     : PRINT : PRINT "INVENT   = I
     NVENTORY OF MX-80 SIGNALS": PRINT
     : PRINT "EDITOR   = SHIFT TO
     APPLEWRITER'S EDITOR"
160  PRINT "PRINTER = SHIFT TO AP
     PLEWRITER'S PRINTER";: PRINT
     "QUIT       = QUIT": PRINT : INPUT
```

Listing 1 continued:

```
170  IF B$ = "INVENT" GOTO 440
180  IF B$ = "STANDARD" THEN A =
     1: GOTO 40
190  IF B$ = "ITALIC" THEN A = 2:
      GOTO 40
200  IF B$ = "STRIKE1" THEN B = 1
     : GOTO 40
210  IF B$ = "STRIKE2V" THEN B =
     2: GOTO 40
220  IF B$ = "STRIKE2H" AND C = 2
      THEN B = 3: GOTO 40
230  IF B$ = "STRIKE2H" GOTO 330
240  IF B$ = "STRIKE4" AND C = 2 THEN
     B = 4: GOTO 40
250  IF B$ = "STRIKE4" GOTO 330
260  IF B$ = "SPACEN" THEN D = 1:
     GOTO 40
270  IF B$ = "SPACET" THEN D = 2:
     GOTO 40
280  IF B$ = "SPACEO" THEN D = 3:
     GOTO 40
290  IF B$ = "SMALL" AND B > 2 GOTO
     330
300  IF B$ = "SMALL" THEN C = 1: GOTO
     40
310  IF B$ = "NORMAL" THEN C = 2
320  GOTO 40
330  HOME : VTAB 12: PRINT "SMALL
      LETTERS CANNOT BE": PRINT "
     COMBINED WITH TWO HORIZONTAL
      STRIKES.": PRINT : GOTO 490

340  PRINT A$"PR# 1": IF D < 3 THEN
      PRINT D$;(4 - 2 * D);: GOTO
     360
350  PRINT D$;"1";
360 E = 80: IF C = 2 THEN E = 81
370  PRINT D$; CHR$ (84);D$; CHR$
     (E): PRINT D$;: IF B < 3 THEN
      PRINT  CHR$ (70);: GOTO 390

380  PRINT  CHR$ (69);
390  PRINT D$;: IF B = 1 OR B = 3
      THEN  PRINT  CHR$ (72);: GOTO
     410
400  PRINT  CHR$ (71);
410  PRINT D$;(6 - A): PRINT A$"P
     R# 0": PRINT A$"OPEN MX.STAT
     US": PRINT A$"WRITE MX.STATU
     S": PRINT A: PRINT B: PRINT
     C: PRINT D: PRINT A$"CLOSE M
     X.STATUS": IF B$ = "PRINTER"
      THEN  PRINT A$"BRUN PRINTER
     "
420  IF B$ = "EDITOR" THEN  PRINT
     A$"BRUN TEDITOR"
430  END
440  HOME : PRINT  TAB( 9)"$ DENO
     TES CHR$(27)=ESC": PRINT "ST
     ANDARD FONT"; SPC( 24);"$5":
      PRINT "ITALIC FONT"; SPC( 2
     6);"$4": PRINT "SINGLE STRIK
     "ENTER INSTRUCTION CODE:  ";
     B$: IF B$ = "QUIT" OR B$ = "
     PRINTER" OR B$ = "EDITOR" GOTO
     340
```

Listing 1 continued on page 170

Listing 1 continued:

```
     E"; SPC( 22);"$F$H"
450  PRINT "TWO VERTICAL STRIKES"
     ; SPC( 15);"$F$G": PRINT "TW
     O HORIZONTAL STRIKES"; SPC(
     13);"$H$E": PRINT "QUADRUPLE
      STRIKES"; SPC( 18);"$E$G": PRINT
     "SMALL LETTERS (16.5/INCH,13
     2/LINE) $T$P"
460  PRINT "NORMAL LETTERS   (10/
     INCH,80/LINE) $T$Q": PRINT "
     * WIDE LETTERS (8.25/INCH,66
     /LINE) $S$P": PRINT "* DOUBL
     E LETTERS  (5/INCH,40/LINE)
     $Q$S": PRINT "* RETURN PRINT
     HEAD LEFT W/O LINEFEED $<": PRINT
      TAB( 8)"* THESE TERMINATE A
     T END OF LINE": PRINT "SPACE
      6 LINES/INCH"; SPC( 19);"$2
     "
470  PRINT "SPACE 8 LINES/INCH"; SPC(
     19);"$0": PRINT "SPACE  #/72
     /INCH (0<#<86)"; SPC( 10);"$
     A #": PRINT "SPACE #/216/INC
     H (0<#<255)"; SPC( 9);"$3 #"
     : PRINT "FORMFEED"; SPC( 23)
     ;"CHR$(12)": PRINT "FORM LEN
     GTH = # LINES (0<#<256)     $
     C #": PRINT "SET HORIZONTAL
     TABS"; SPC( 6);"$D #1 #2 ...
      0"
480  PRINT "HORIZONTAL TAB MOVE";
      SPC( 8);"POKE 49296,9": PRINT
     "SET VERTICAL TABS"; SPC( 8)
     ;"$B #1 #2 ... 0": PRINT "VE
     RTICAL TAB MOVE"; SPC( 14);"
     CHR$(11)"
490  INPUT "PRESS 'RETURN' TO CON
     TINUE. ";C$: GOTO 40
```

Text continued from page 166:

the first time it is run, I've included a brief program, shown in listing 2, that creates a status file. (Listing 2 also shows the italic font that is available with the Graftrax-80.)

Listing 2: *This program creates a disk file, called MX.STATUS, that is accessed by the program in listing 1. You must run this short program prior to running the MX-80 printer program for the first time.*

```
10  REM THIS PROGRAM CREATES
       A FILE, MX.STATUS, OF
       PARAMETERS THAT ARE
       USED BY THE MX-80
       PROGRAM.
20 A = 1:A$ =  CHR$ (4): PRINT A$
    "OPEN MX.STATUS": PRINT A$"W
    RITE MX.STATUS": PRINT A: PRINT
    A: PRINT A: PRINT A: PRINT A
    $"CLOSE MX.STATUS"
```

The print-control program is designed for the Applewriter word processor, but can be adapted to other text editors by modifying lines 150, 160, 410, and 420. To use the program with Applewriter:

1. Enter S to save the text file.
2. Enter Q to quit Applewriter.
3. Enter RUN MX-80.
4. Turn on the printer.
5. Enter choices from the menu.
6. Enter Printer to quit the MX-80 program.
7. Enter L to load the text file.
8. Enter P to print.

Do not turn the printer off between running the print-control program and the actual printing because your choices will be lost as the printer resets to its default options (STANDARD, STRIKE1, NORMAL, SPACEN). You may switch the printer offline and manually advance the paper by pressing the formfeed or linefeed buttons without affecting the typeface settings.■

Graphics II by Selanar

High-Resolution Hard Copy from a DECwriter

Daniel Macero, Daniel Holmes
Thomas Banks and Lloyd Burgess
Department of Chemistry
Syracuse University
Syracuse, NY 13210

A picture, a thousand words, or both—that's what you can print out on a DECwriter II terminal outfitted with the Selanar Graphics II attachment. This versatile modification provides a host of features for the DECwriter (by Digital Equipment Corporation): high-resolution graphics, bidirectional linefeed, multiple character sets, the ability to print standard, boldface, and double-width characters that can be rotated in any one of four directions, and several other useful options that cost extra if purchased from DEC.

Our interest in this unit began when we saw it featured in the new-products section of a digital-electronics trade magazine. We were especially interested in the claim that, with this attachment, a dot could be printed anywhere on a standard DECwriter page and that up to 1,045,440 points could be addressed. For $850 (less a 5 percent educational discount), this seemed like a low-cost way to high-resolution graphics, so we ordered a Graphics II modification from Selanar Corporation.

In less than three weeks the unit arrived. The box contained the Graphics II circuit board, a power cable consisting of three wires: blue, black, and orange (the same color-coding used by DEC), six #8 nylon screws and nylon washers (already attached to the circuit board), and a user's manual.

Installation and Testing

With the help of the user's manual, installing the Graphics II board was simple and straightforward. First, we examined the board for any damaged or loose components. (The manual provides a list of likely sources of trouble.) In our case, we found the ground connection of the TTL (transistor-transistor logic) interface socket (J4) to be loose and had to touch it up with a bit of solder; otherwise, everything was in order.

Next, the board was prepared for installation by selecting from the several available jumper options (i.e., parity, bell, serial interface, and data-transfer rate). Step-by-step instructions are accompanied by two full-page photographs that show the inside of the DECwriter before and after installation of the Graphics II board. The photos are invaluable for locating and identifying the various components important to the installation.

Following the instructions given in the user's manual, the original DECwriter board was removed. (A screwdriver is all that is necessary for this and the following operations.) The Graphics II board was attached to the

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six mounting points on the DECwriter back panel using the attached nylon hardware. The cables provided with the DECwriter were then connected to the new circuit board and the three-wire cable was connected to the terminal's power supply. This completed the assembly of the unit.

Sufficient warnings are included at each step to insure a virtually foolproof installation. Total installation time was about 30 minutes. After verifying that all connectors to the Graphics II board and all components on the board were secure, and that there were no loose parts, tools, or other items left on the circuit board or in the internal cabinet area of the terminal, the unit was ready for testing.

The testing procedure is straightforward and can be done without sophisticated test equipment. By switching the DECwriter to local operation, the user can run through the various features, including graphics, and verify that everything is working properly. Once everything is operational, the I/O (input/output) interface is checked and the printer is ready to use.

At a Glance

Name
Graphics II

Use
Enhancement to the DECwriter II printer

Manufacturer
Selanar Corporation
3054 Lawrence Expressway
Santa Clara, CA 95051

Dimensions
48.3 × 26.7 cm (19 × 10.5 inches)

Price
$895

Hardware Needed
DECwriter LA35 or DECwriter LA36

Software Needed
None

Hardware Options
Precision tractors, $50 extra

Documentation
50-page manual, includes schematics

Audience
DECwriter owners desiring high-resolution hard-copy graphics

Features
Print speed:character mode, average 36 cps—graphics mode, average 1 ips; transmission rates: selectable to 1200 bps, with X-on and X-off; interfaces: 20 mA current loop, EIA RS232, TTL (for modem); line length: character mode, 132 characters—graphics mode, 1320 dots; spacing: character mode, horizontal, 10 cpi—vertical, 6 lpi; graphics mode: horizontal, 100 dots per inch—vertical, 72 dots per inch; four complete character sets including uppercase and lowercase: ASCII character set, APL character set, Math/Greek character set, user-defined character set (load from keyboard or computer into memory); boldface: all characters; four rotations: all characters; double width: all characters

Paper
Variable width 7.6 cm (3 inches) to 37.8 cm (14⅞ inches); up to 6-part forms 0.020 in maximum thickness; tractor-drive line feed

Power Requirements
120 V AC 50/60 Hz

Printer Adjustment

Our unit worked immediately and we were soon printing out the different character sets in boldface and double-width; however, some characters did not seem well formed. In addition, the tractor drive had a tendency to slip. The character problem, we were told, was caused by minor variations in parts such as the drive and stepper motors used in different DECwriters; this can result in different levels of performance depending on the user's specific terminal. To compensate for these variations, the Graphics II unit has built-in adjustments that can be set to obtain optimum performance. An oscilloscope, preferably one with dual-trace capability, is necessary for making these adjustments. The procedure outlined in the user's manual gives two types of adjustments: print columns and print-speed control. In our case, we simply adjusted the forward and reverse print-speed controls and the characters printed out perfectly.

In operation, the enhanced DECwriter can function as an unmodified terminal, as a terminal featuring many of the options offered by DEC at extra cost, and in the graphics mode (a completely new feature). System commands are selected by





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Control Code	Name	Description
cL	Form feed	Advance paper to beginning of next form (top of page).
cN	APL character set	Selects second character set (factory set with APL characters). Once selected, all characters printed are as defined from this PROM.
cO	Normal character set	Selects normal character set.
ESC 5	Print entire character set	Test mode.
ESC 7	Upside-down print mode	Rotates characters 180°.
ESC 8	Sideways I print mode	Rotates characters 90°.
ESC 9	Sideways II print mode	Rotates characters 270°.
ESC 0	Double-width characters	Prints double-width characters.
ESC A	Boldface characters	Prints each character in boldface.
ESC C	Special reset	Returns DECwriter to normal configuration.
ESC F	Power-up reset	Resets all modes, character styles, tabs, and top of form (also occurs at power-up).
ESC G	Up 1/4 line	Moves paper up 1/4 line at a time.
ESC H	Down 1/4 line	Moves paper down 1/4 line at a time.
ESC N	Third character set	Selects third character set (factory set for mathematics symbols and selected Greek letters).
ESC P	Fourth character set	Selects fourth character set as defined in programmable memory.
ESC Q	Load-memory character set	Defines fourth character set to be loaded into programmable memory.
ESC B	Enter graphics mode	Enters graphics mode. All characters ignored except "(" "," "." "]", and digits 0 through 9
ESC J	Set bar mode	In graphics mode, prints all seven dots instead of one at a time.
ESC C	Exit graphics mode	

Table 1: *Command codes used by the LA36 DECwriter II with the Selanar Graphics II modification. Codes in the table preceded by a lowercase "c" are entered by holding down the Control key while entering the indicated code (similar to the standard procedure for typing any uppercase letter by using the shift key). Other codes are entered by typing ESC (escape) followed by the indicated letter.*

either a Control code or an ESC (escape) code. The Control code is obtained by simultaneously pressing the Control key and another key to select a given function. The ESC code is a two-step operation: first the ESC key is pressed, then the key that selects the desired function. Pressing ESC a second time cancels this command sequence. Table 1 is a list of some of the more important ESC and Control commands that function in the normal (nongraphics) and graphics modes.

Other system commands that can be implemented with Graphics II are horizontal tab control (advances the print head to the next column position with a set tab); vertical tab (advances the paper vertically to the next line with a vertical tab); set horizontal tab (sets a tab where the head is positioned, up to 16 tabs may be set); reset horizontal tab (resets the individual horizontal tabs at each desired head position); set vertical tab (sets a tab to any one or all of 16 vertical tab positions); and reset vertical tab (resets an individual vertical tab at the present position of the print head).

In addition, you can activate the bell, reset the top-of-form position, enable the automatic linefeed with carriage return, backspace, and issue a special *Here-is* message where up to

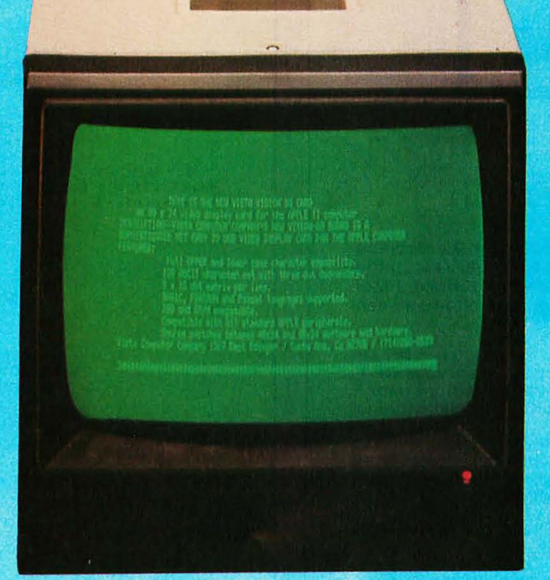
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32 characters encoded in PROM (programmable read-only memory) are transmitted as if from the keyboard (e.g., for an automatic password sign-on to a remote computer).

"Normal" Printing Operations

In the printing mode the Selanar Graphics II acts as a normal DECwriter printer with enhanced capabilities. We can select any one of four character sets: standard, APL, mathematical, and user-defined. The first three sets are encoded in PROM, the fourth is stored in programmable memory. The fourth character set may be loaded from the host computer or entered manually from the keyboard; once loaded, it remains in memory until the DECwriter is turned off.

The programmable character set can contain up to 94 printable characters. Each of these is represented as a 7-by-7 dot matrix with the top dot corresponding to the most significant bit and the bottom dot to the least. Seven bytes are required to define each character: one for each column of the matrix. For convenience in entering characters from the keyboard, each byte can be entered as an ASCII (American Standard Code for Information Interchange) character.

Using the boldface character option, we are able to emphasize words and headings, or even print out an entire document in this type style for a more pleasing appearance. Figure 1 shows the first three character sets and the various type styles available with the Graphics II enhanced DECwriter. The one-quarter-up and one-quarter-down linefeed option is invaluable for printing the superscripts or subscripts that are often necessary when writing chemical or mathematical equations (see figure 1), as well as printing chemistry manuscripts, examinations, and writing computer-assisted instruction units.

Data Buffer

The Graphics II unit also has a 1000-character buffer for serial I/O. In this mode, the printer will automatically print characters as fast as it can. Data not ready for printing will be temporarily stored in the buffer; however, the programmer must be careful not to overflow the buffer. To prevent this, an X-off character is sent to the host computer when the buffer is filled to within 100 bytes of overflow; an X-off character is then sent for every additional character received. When the buffer is emptied to fewer than 100 characters, an X-on character is transmitted. Thus, the programmer does not have to worry about overflowing the buffer or other timing considerations, and data transfer rates of up to 1200 bps (bits per second) are possible. The X-on/X-off option need not be used if the programmer is careful to take into account the time needed to execute a carriage return and line feed, horizontal tab, vertical tab, graphic vectors, and Here Is, to avoid overflowing the buffer.

GRAPHICS II CHARACTER SETS

STANDARD

```
!"#$%&'()*+,-./0123456789:;<=>?
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
`abcdefghijklmnopqrstuvwxyz}\{~

!"#$%&'()*+,-./0123456789:;<=>?
@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^-
`abcdefghijklmnopqrstuvwxyz{|}~

! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?
@ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ -
` a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
```

MATHEMATICS

```
!'≈^%&•()*+,-./0123456789:;X≡□∇
ΑΒΓΔΕΖΗΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ∴±◊♀ƒ↑Ø
∫αβγδεζηθικλμνξοπρστυφχψω«»/∠
```

APL

```
")<≤=>]∨∧≠÷,+./0123456789([;×:\
¯α⊥∩⌊ε_∇∆⍳∘'⎕|⊤○*?ρ⌈~↓∪ω⊃↑⊂←⊢→≥-
◊ABCDEFGHIJKLMNOPQRSTUVWXYZ{⊣}$
```

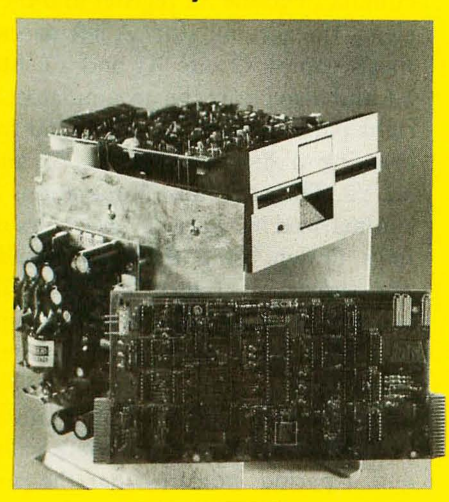
CHEMICAL EQUATIONS

(2) $Cu^{2+} + 2Cl^{-} \rightarrow Cu(s) + Cl_2(g)$

Figure 1: *The character sets and type styles preprogrammed into the Graphics II modification. Under the Normal printing mode, subscripts and superscripts can be printed easily with the 1/4 linefeed capability, and characters may be printed as boldface, large, or double width.*

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DRIVE NO. 2	569.00

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DRIVE NO. 4	359.00
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(2a)

THE GRAPHICS MODE

```
ACCUMULATOR          GRAPHICS COMMANDS
 |      |
X2     Y2        (   X2 TO X1, Y2 TO Y1,
 |      |            CLEAR ACCUMULATOR
 |      |
X1     Y1        ,   ACCUMULATOR TO X2, AND CLEAR

                 .   ACCUMULATOR TO Y2, AND CLEAR

                 )   DRAW LINE FROM X1,Y1 TO X2,Y2

                     POSITION PRINT HEAD TO X1,Y1
```

(2b)

EXAMPLES USING GRAPHICS COMMANDS

```
LOCAL - (800,200.(900,)(1000,150.)

BASIC - LPRINT "(";STR$(800);",";STR$(200);".(";STR$(900);
              ",)(";STR$(1000);",";STR$(150);".)"

LOCAL - (900,500.(1000,450.)800,450.)800,550.)1000,550.)
```

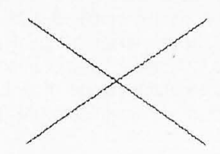


Figure 2: *Graphics-mode sample output. Figure 2a gives a summary of the graphics command procedures, as printed in the graphics mode. Figure 2b shows how straight lines are drawn.*

Graphics Operation

The graphics mode is entered at any time with an ESC B and exited with a ESC C command. Graphics are done a page at a time, with each page consisting of 792 lines with 1320 dots per line. The origin (0,0) is located at the upper left-hand corner of the page; the bottommost right-hand corner corresponds to the point (1319,791).

In the graphics mode, the system responds only to the digits 0 through 9, parentheses, the right bracket, the comma, and the period; all other characters are ignored.

The comma transfers the previously entered number from the accumulator to the X2 register and then clears the accumulator. A left parenthesis copies X2 into X1 and Y2 into Y1 and also clears the accumulator; a right parenthesis is the command for drawing a line between X1,Y1 and X2,Y2. This sequence of operations is summarized in figure 2a. Examples of lines drawn using these commands are shown in figure 2b. Also illustrated is a BASIC print statement that shows the method of drawing lines under program control. Note that a comma indicates that the number preceding it is an ordinate value and a period indicates that the preceding number represents an abscissa.

Thus, (A,B.(C,D.) will draw a line between A,B and C,D; (A,B.(C,) draws a horizontal line between A,B

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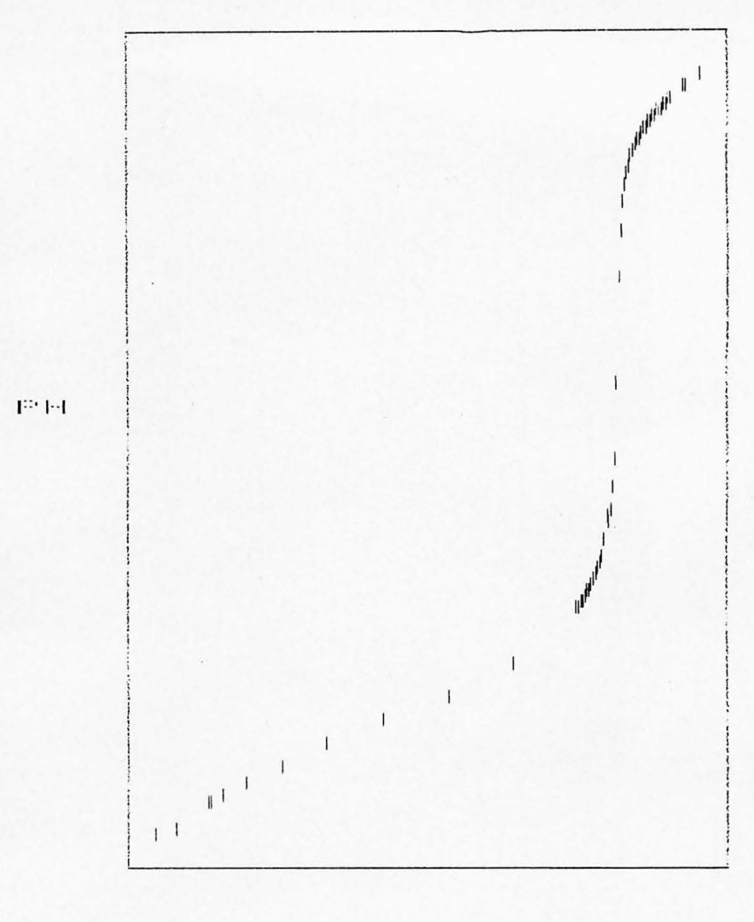


Figure 3: *Typical acid/base titration curve. Data points are drawn as short bars, the curve is enclosed by a border, and the heading and labels are printed double width.*

and C,B; (A,B.() prints a single dot; and the right bracket, as in A,B.(], positions the print head at location A,B without printing. Two examples are illustrated in figure 2b where, in the top example, a horizontal line is drawn between the points 800,200 and 900,200 and then a line from 900,200 to 1000,150. The intersecting lines in the bottom example are drawn in the same manner. First, a line is drawn between the points 900,500 and 1000,450; then a line between 900,500 and 800,450; a line between 900,500 and 800,550; and finally, a line between 900,500 and 1000,550.

The Use of Precision Tractors

Another modification of the DECwriter, which is particularly useful in graphics mode, is the installation of a set of precision paper-feed tractors in place of the standard tractors supplied with a conventional DECwriter. (These can be obtained from the Selanar Corporation for $50.) Their purpose is to insure that lines originating from the same point (such as in a radial pattern) begin at that point every time a new line is drawn—otherwise the pattern shows a distinct discontinuity. The improvement in the printed results due to the use of the precision tractors can be seen in



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(4a)

EXAMPLES OF HERSHEY CHARACTER ALPHABETS

ABCDEFGHIJ

ABCDEFGHIJ

abcdefghij

ABCDEFGHIJ

ABCDEFGHIJ

ABCDEFGHIJ

abcdefghij

(4b)

USE A 2-D ROTATIONAL ALGORITHM

$$\begin{vmatrix} X_1 & Y_1 & 1 \\ X_2 & Y_2 & 1 \\ X_H & Y_H & 1 \end{vmatrix} * \begin{vmatrix} \cos(Q) & -\sin(Q) & 0 \\ \sin(Q) & \cos(Q) & 0 \\ 0 & 0 & 0 \end{vmatrix} = \begin{vmatrix} X_1 & Y_1 & - \\ X_2 & Y_2 & - \\ X_H & Y_H & - \end{vmatrix}$$

EXAMPLES

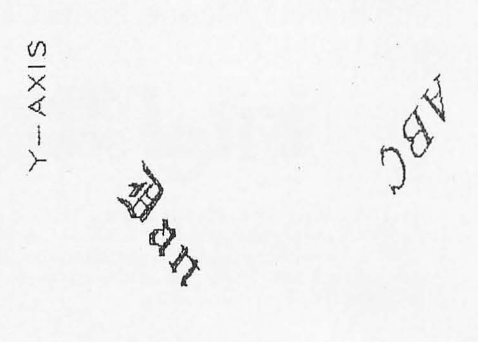


Figure 4: *Various type fonts produced by the program of listing 1 from data stored on disk. The rotation feature is shown in figure 4b.*

figure 2b, where the lines all originate from the point 900,500. The precision tractors are no trouble to install and otherwise perform exactly like the original tractors.

Figure 3 shows a typical acid/base titration curve. Note the use of the double-width characters to label the graph, the box enclosing the curve, and the use of the bar-print mode to emphasize the individual data points. This graph was generated with a FORTRAN program and is a good example of the combined use of printing characters and graphics. The four character sets, double-width, boldface, and character rotation options all make the Selanar Graphics II board a powerful addition to any DECwriter.

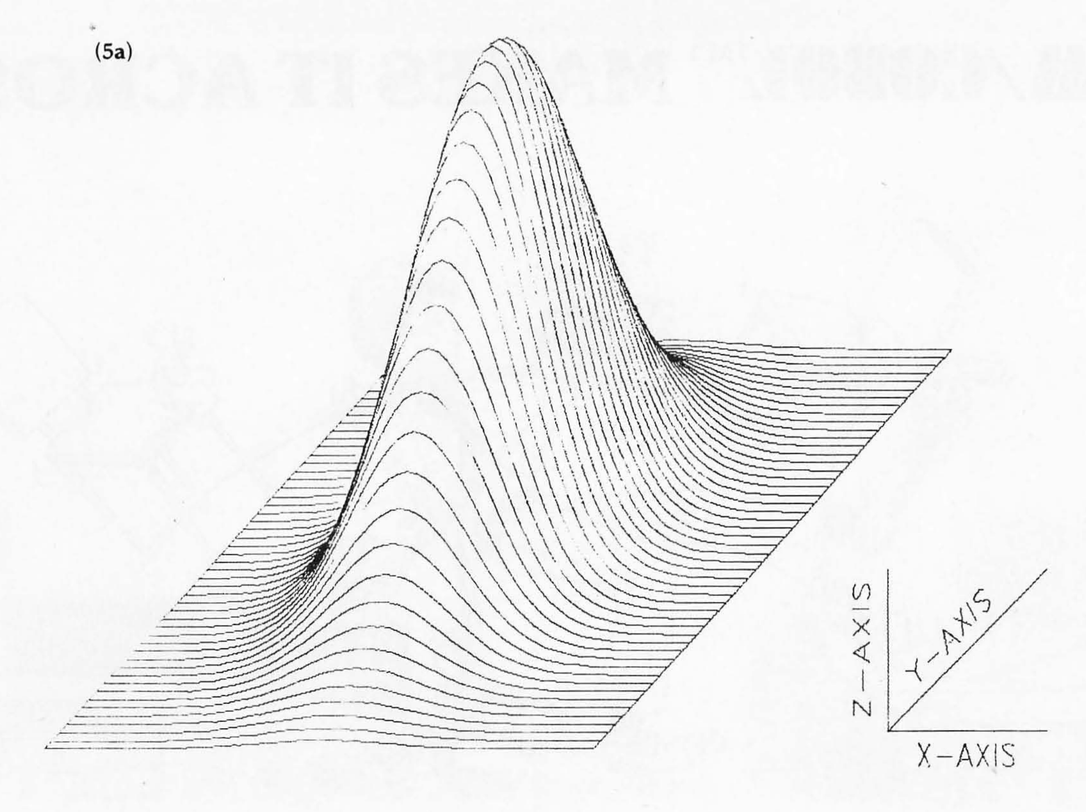
Generating Character Sets

The excellent resolution available with the Graphics II and the fact that it prints vector-generated graphics prompted us to explore the use of graphics to draw characters as well as plot curves. Normally, we would have to do this by developing tables of coordinates for each alphanumeric character. But fortunately, there is an invaluable reference work that provides all the information needed: *A Contribution to Computer Typesetting Techniques: Tables of Coordinates from Hershey's Repertory of Occidental Type Fonts and Graphic Symbols.* (Published by the U.S. Department of Commerce, the book is now out of print, although many libraries have a copy.)

This document lists the coordinates used to generate 1377 different alphabetic and graphic characters on either a video terminal or a hard-copy digital plotter. The tables were originally developed by Dr. A. V. Hershey of the Naval Weapons Laboratory in Dahlgren, Virginia. Dr. Hershey's assiduous digitization of these many character sets and symbols is as much a work of art as it is a scientific achievement, and it includes symbols from mathematics, engineering, music, and other disciplines. The typeset quality of the characters and symbols is certain to enhance any graphics display.

Figure 4a presents several examples

Text continued on page 196



PLOT OF EXP(-(X^2+Y^2))

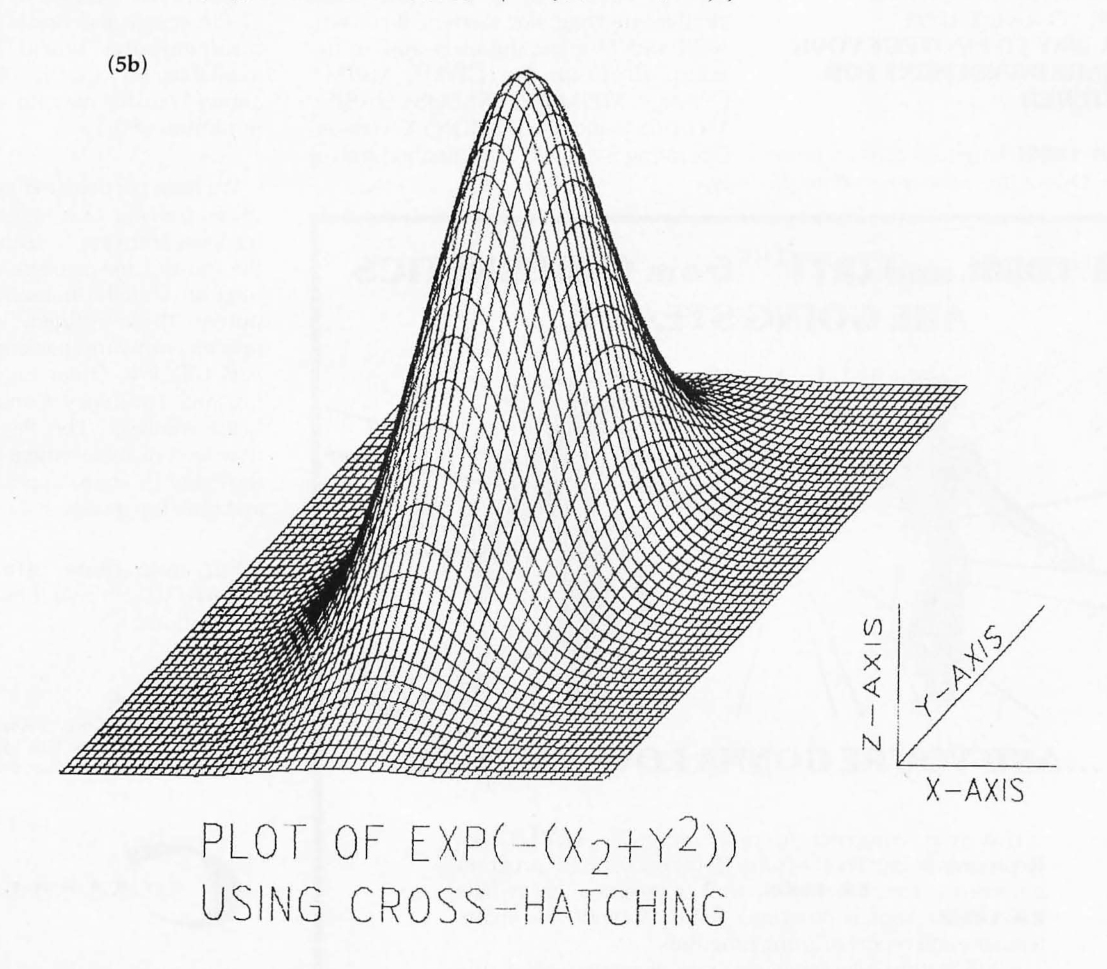
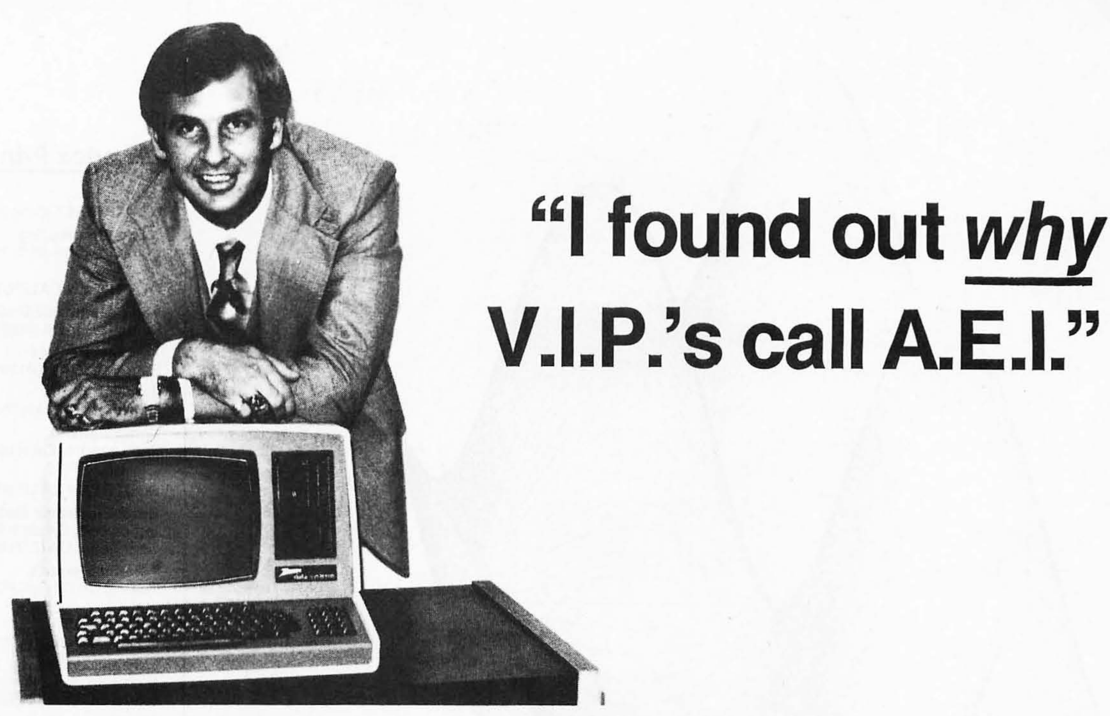


Figure 5: *Three-dimensional plotting in the graphics mode. Figures 5a and 5b show the same function but with differing detail; figure 5c (on page 190) is a "two-dimensional particle in a box."*



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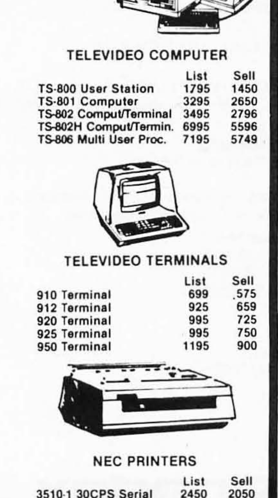
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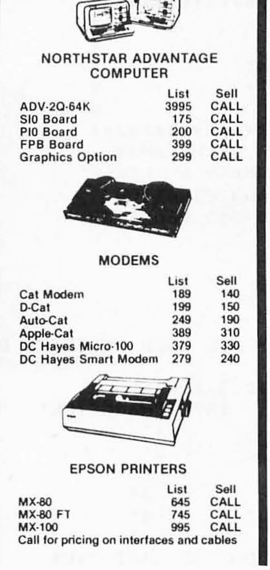
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Okidata 83A	1195	899
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Anadex 9501	1650	1285

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DMB-6400 Memory	995	735
CPC-2813 CPU + I/O	460	365
FDC-2801 Controller	465	370

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Apple Wordstar	375	275
Spellstar	250	190
Mailmerge	150	100
Datastar	350	250
Supersort	250	190

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Memorex 5" 2D	55	36
Verbatim 5" 1D	40	30
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RS-232 10' Cable	40	25

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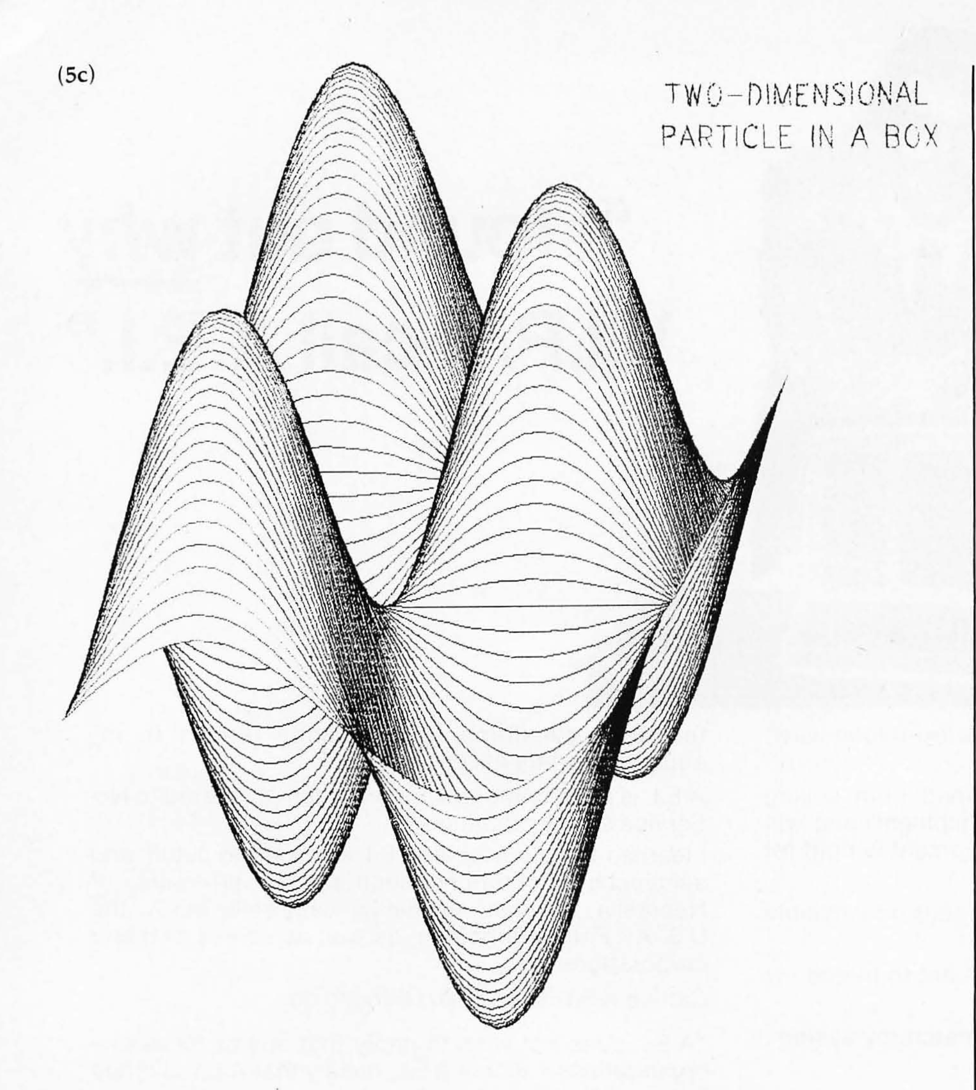


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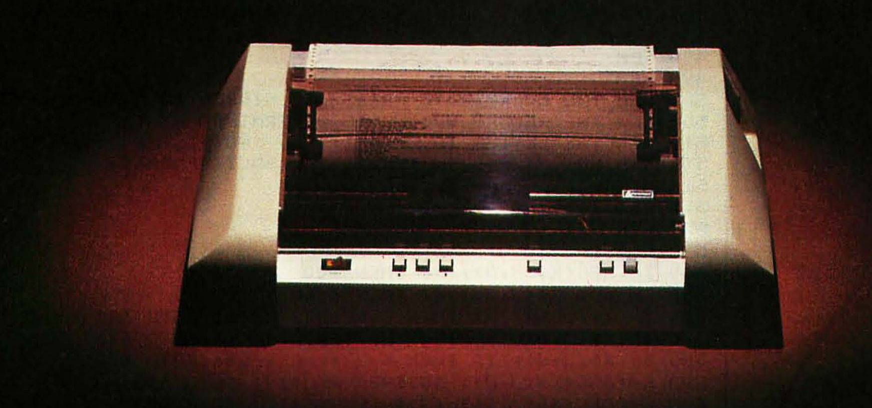
Listing 1: *Program used to print characters in the various type fonts from data stored on disk. The program (written in Microsoft BASIC-80, Version 5.0) produces output, such as that shown in the figures, on the modified DECwriter.*

```
10 REM ***************************************************
15 REM *                                                 *
16 REM *                DANIEL S. HOLMES                 *
17 REM *              CHEMISTRY DEPARTMENT               *
18 REM *               SYRACUSE UNIVERSITY               *
21 REM *                                                 *
22 REM ***************************************************
30 REM THIS PROGRAM OUTPUTS ANY OF A NUMBER OF HERSHEY
32 REM CHARACTERS AS TEXT.  THE TEXT AND NUMBER OF LINES
34 REM ARE USER SELECTED, ALONG WITH THE MAGNIFICATION
36 REM FACTOR, AND THE ANGLE OF ROTATION (0-360 DEGREES).
38 REM
40 REM
42 REM  ENTER GRAPHICS MODE
44 LPRINT CHR$(27);"B"
46 REM
47 REM THIS PART OF THE PROGRAM IS TO INPUT ALL USER SELECTED DATA
48 REM
50 DIM X$(10,100),A$(250),A(250), S(3,120),Q(3,120)
70 PRINT " CHARACTER SETS                         #REC/CHARACTER"
80 PRINT "CROMAN                                        1"
90 PRINT "SIMSCRIPT                                    2"
100 PRINT "COMITPRN                                     2"
110 PRINT "TROMAN3                                      3"
120 PRINT "GOTHICENG4                                   4"
130 PRINT "LCGOTH3                                      3"
140 PRINT:PRINT:INPUT "WHICH CHARACTER SET DO YOU WANT ";C$
150 OPEN "R",1,C$
160 PRINT : INPUT "# RECORDS / CHARACTER ";REC
190 PRINT
200 PRINT "             ENTER TEXT":PRINT
210 INPUT "# OF LINES (UP TO TEN) ";Q2
```

Listing 1 continued on page 192

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Listing 1 continued:

```
220 PRINT : PRINT "USE CONTROL-H TO BACKSPACE"
230 FOR J=1 TO Q2
240 PRINT "---------------LINE ";J;"---------------"
250 X=1
260 X$(J,X)=INPUT$(1)
270 IF ASC(X$(J,X))=8 THEN X=X-1 : PRINT CHR$(8); : GOTO 310
280 IF X$(J,X)=CHR$(13) THEN 320
290 PRINT X$(J,X);
300 X=X+1
310 GOTO 260
320 PRINT
330 D(J)=X-1
340 NEXT J
350 PRINT :PRINT
360 INPUT "IS THIS THE STRING YOU WANTED ";Y$
370 IF Y$="YES" THEN 390 ELSE 170
390 INPUT " WHAT MAGNIFICATION POWER ";MAG
400 PRINT
410 INPUT "WHAT ROTATION ANGLE (0-360) ";T1
420 T2=T1/57.2958
430 PRINT
440 INPUT "WHAT IS THE STARTING POINT ON THE PAGE ";A,B
450 A1=A : B1=B
490 REM
495 REM
500 REM THE COORDINATE PAIRS ARE STORED IN A RANDOM ACCESS FILE
505 REM THE RECORD NUMBER IS DETERMINED BY THE ASCII VALUE OF
510 REM THE LETTER TO BE WRITTEN.  NOTE: THE CHARACTERS ARE
515 REM NOT STORED IN SEQUENTIAL ASCII FORMAT.
516 REM
517 REM
520 FOR J=1 TO Q2
530 FOR Q=1 TO D(J)
540 IF ASC(X$(J,Q))>96 THEN 600
550 IF ASC(X$(J,Q))>64 THEN 610
560 IF X$(J,Q)=" " THEN C=27*REC-REC+1:GOTO 620
570 IF X$(J,Q)="=" THEN C=28*REC-REC+1:GOTO 620
580 IF X$(J,Q)="?" THEN C=29*REC-REC+1:GOTO 620
590 C=(ASC(X$(J,Q))-10)*REC-REC+1 : GOTO 620
600 C=(ASC(X$(J,Q))-47)*REC-REC+1 : GOTO 620
610 C=(ASC(X$(J,Q))-64)*REC-REC+1
620 PRINT "THE RECORD # IS ";C
630 REM
635 REM
640 REM HERE WE GET THE COORDINATE PAIRS.
645 REM SOME OF THE CHARACTER SETS TAKE UP MORE
650 REM THAN ONE RECORD/CHARACTER.
660 REM
665 REM
670 FIELD #1,1 AS M$,2 AS L$,2 AS R$,2 AS H$
680 Z=0
690 FOR G=1 TO  59   STEP 2
700 FIELD #1,Z*4+7 AS D$,2 AS A$(G),2 AS A$(G+1)
710 Z=Z+1
720 NEXT G
730 GET #1,C
740 L=CVI(L$)
750 R=CVI(R$)
760 H=CVI(H$)
770 I=1
780 A(I)=CVI(A$(I))
790 A(I+1)=CVI(A$(I+1))
800 IF A(I+1)=-64 THEN 1100
810 IF I=59 THEN 850 ELSE I=I+2 : GOTO 780
840 GOTO 1100
850 H1=60
860 FOR Y=1 TO REC-1
870 I=0
880 FOR X=H1+1 TO H1+59 STEP 2
890 FIELD #1,I*4 AS D$,2 AS A$(X),2 AS A$(X+1)
900 I=I+1
910 NEXT X
920 C=C+1
930 GET #1,C
940 FOR X=H1+1 TO H1+59 STEP 2
950 A(X)=CVI(A$(X))
960 A(X+1)=CVI(A$(X+1))
970 IF A(X+1)=-64 THEN 1100
980 NEXT X
990 H1=H1+60
1000 NEXT Y
1050 REM
1055 REM
1060 REM THIS IS THE PART OF THE PROGRAM THAT OUTPUTS
1065 REM THE LETTER TO THE DECWRITER.  THE DECWRITER
1070 REM ACCEPTS THE STRING REPRESENTATION OF EACH CHARACTER.
1075 REM A (-64,0) IS A LIFT PEN INSTRUCTION.
```

Listing 1 continued on page 195

A Good-Buy Present.

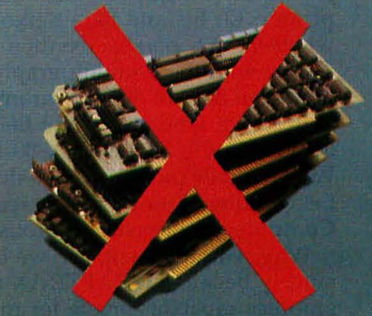
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And your software could be your "softwear."



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Listing 1 continued:

```
1080 REM A (-64,-64) IS AN END OF CHARACTER INSTRUCTION.
1090 REM
1095 REM
1100 A=A-L*MAG*COS(T2)
1110 B=B-L*MAG*-SIN(T2)
1120 GOSUB 2000
1130 IF H=1 THEN 1300
1140 LPRINT "(";STR$(INT(A(1)*MAG+A));",";STR$(INT(A(2)*MAG+B));".(J"
1150 FOR G=1 TO H*2-1 STEP 2
1160 IF A(G+1)=-64 THEN 1300
1170 IF A(G)=-64 THEN 1270
1180 A(G)=A(G)*MAG
1190 A(G+1)=A(G+1)*MAG
1200 A(G)=A(G)+A
1210 A(G+1)=A(G+1)+B
1220 LPRINT "(";STR$(INT(A(G)));",";STR$(INT(A(G+1)));".";
1230 IF V=1 THEN 1250
1240 LPRINT ")";
1250 V=0
1260 GOTO 1290
1270 LPRINT
1280 V=1
1290 NEXT G
1300 A=A+R*MAG*COS(T2)
1310 B=B+R*MAG*-SIN(T2)
1320 NEXT Q
1360 REM
1365 REM
1370 REM NOW WE GO BACK TO THE START OF THE NEXT LINE
1380 REM
1390 REM
1400 IF REC>1 THEN 1440
1410 A1=A1+15*MAG*SIN(T2)
1420 B1=B1+15*MAG*COS(T2)
1430 GOTO 1465
1440 A1=A1+30*MAG*SIN(T2)
1450 B1=B1+30*MAG*COS(T2)
1465 A=A1 : B=B1
1470 NEXT J
1472 REM
1475 REM
1480 REM CHECK FOR ANYTHING ELSE TO PRINT OUT
1490 REM
1495 REM
1500 INPUT "DO YOU HAVE MORE TEXT ";Y$
1510 IF Y$="NO" THEN 1550
1520 PRINT
1530 INPUT "DO YOU WANT TO CHANGE CHARACTER SETS ";Y$
1540 IF Y$="YES" THEN CLOSE : GOTO 70
1542 REM
1543 REM
1545 GOTO 190
1547 REM
1548 REM
1550 LPRINT CHR$(27);"C"
1560 END
2000 REM
2010 REM
2020 REM THIS IS THE ROTATIONAL ALGORITHM USED TO ROTATE THE
2030 REM CHARATERS ANY ANGLE FROM 0-360 DEGREES.
2033 REM THE COORDINATE PAIRS ARE STORED IN A 3*3 MATRIX,AND
2035 REM MULTIPLIED BY THE ROTATION MATRIX (ROTATION ABOUT
2038 REM THE POINT 0,0).
2040 REM
2045 REM
2050 IF T1=0 THEN RETURN
2060 FOR I=1 TO H
2070 S(1,I)=A(I*2-1)
2080 S(2,I)=A(I*2)
2090 S(3,I)=1
2100 NEXT I
2110 T(1,1)= COS(T2)
2120 T(2,2)=COS(T2)
2130 T(1,2)=SIN(T2)
2140 T(2,1)=-SIN(T2)
2150 T(3,1)=0
2160 T(3,2)=0
2170 T(3,3)=1
2180 FOR Y5=1 TO H
2190 IF A(Y5*2-1)=-64 THEN 2250
2200 FOR X5=1 TO 3
2210 Q(X5,Y5)=S(1,Y5)*T(X5,1)+S(2,Y5)*T(X5,2)+S(3,Y5)*T(X5,3)
2220 NEXT X5
2230 A(Y5*2-1)=INT(Q(1,Y5)+.5)
2240 A(Y5*2)=INT(Q(2, Y5)+.5)
2250 NEXT Y5
2260 RETURN
```

Text continued from page 186:
of Hershey-character alphabets. Starting from the top of the figure, these are: simplex Roman, simplex script, complex italic, triplex Roman, and Gothic English. At our laboratory, we now have the coordinates of these various character-printer sets stored on disk and can send them to the DECwriter under program control in any size desired. The coordinates for the simplex Roman characters occupy approximately 7K bytes of disk storage space, while the Gothic English files require more than four times that amount.

In addition to being able to vary the size of the displayed Hershey character sets, we also included in our program the ability to rotate characters to any angle. The effects of this routine, adapted from *Mathematical Elements for Computer Graphics*, by D. F. Rogers and J. A. Adams (see references), are shown in figure 4b, which displays several examples of character rotation; also shown is the rotational algorithm that does the calculations necessary for the individual rotations. The BASIC program that outputs the Hershey coordinates as letters, starting at any location on the page, with any magnification and any degree of rotation, is given in listing 1.

Figure 5a is a three-dimensional plot of an exponential function showing the use of the graphics mode to display the lettering as well as the mathematical function itself. Figure 5b is a three-dimensional plot of the same function with certain lines hidden, with cross hatching, and labeled with graphically generated Hershey characters. Finally, shown in figure 5c is the three-dimensional representation of the quantum-mechanical wave function for a two-dimensional particle in a box.

Conclusion

The Selanar unit has been in operation in our laboratory for over a year and has performed flawlessly during that time. The illustrations of the various graphs shown, especially the three-dimensional plots, with or without hidden lines, coupled with the development of programs to encode and output the different Hershey character sets, has made our DECwriter a truly versatile and low-cost generator of high-quality, high-resolution hard copy.■

References

1. *GRAPHICS II Installation and User Manual*. Selanar Corporation, Santa Clara, CA 1979.
2. Rogers, D.F. and J.A. Adams. *Mathematical Elements for Computer Graphics*. New York: McGraw-Hill, 1976, page 202.
3. Wolcott, N.M. and J. Hilsenrath. *A Contribution to Computer Typesetting Techniques: Tables of Coordinates from Hershey's Repertory of Occidental Type Fonts and Graphic Symbols*. Washington, D.C.: National Bureau of Standards Special Publication No. 424, U.S. Department of Commerce, U.S. Government Printing Office, 1976. Out of print.



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Dataroyal tests our IPS-5000 printers non-stop at 100% duty cycle and page density. These printers have now surpassed an MTBF (mean time between failure) figure of 2000 hours-*without failure, maintenance, or any special treatment.* Under normal conditions, this performance rating means years of reliable operation between service calls.

And our printhead life now exceeds 500 million characters. All of this reliability spares you the time and expense you might now be spending on your existing printers.

This superior performance has made Dataroyal the intelligent choice for major domestic and international OEM systems manufacturers. Want to see our proof? Contact us, and we will send you our latest test results. And *that's* not just talk.

235 MAIN DUNSTABLE ROAD, NASHUA, NH (USA) 03061
(603) 883-4157

2801 FAR HILLS AVENUE, SUITE 200, DAYTON, OHIO 45419
(513) 294-6426

3150 EAST LAPALMA AVENUE, SUITE D, ANAHEIM, CA. 92806
(714) 632-9310

DATAROYAL
INCORPORATED

Circle 117 on inquiry card.

Custom and Standardized Forms for the Microcomputer User

Philip Lemmons
c/o BYTE Publications Inc.
POB 372
Hancock, NH 03449

To help you find forms for your software, we are offering this brief account of the current marketplace of forms for microcomputer users.

Some microcomputer users have written their own software; others have bought one or more commercial programs. Many microcomputer users run both software of their own and commercial programs.

A number of companies stand ready to help you with various *stock*, *custom*, or *standardized* forms. Table 1 (page 200) lists companies active in this market. Table 2 (page 202) summarizes the product offerings of these companies and the minimum orders required for custom and standardized forms. I have also included brief information about these companies' offerings, if any, of continuous custom letterheads.

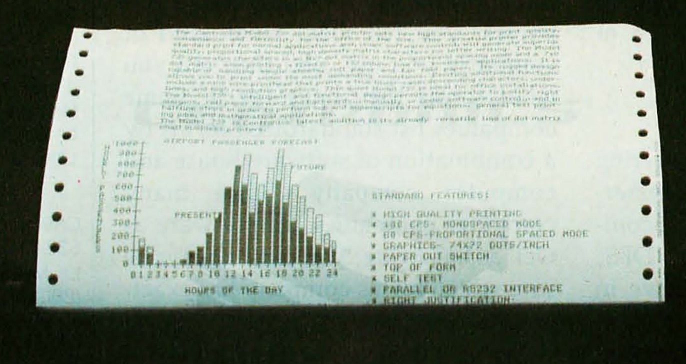
While stock forms are of several common types, they are not written specifically for one company's computer or software. Nevertheless, stock forms *do*, in fact, work with many commercial programs. Companies offering stock forms are too numerous to list. If stock forms will work with your commercial programs, or if you can write software that uses stock forms, you will be able to get the forms you need at an economical price. Some companies make the use of stock forms easier by providing programmer's guides for use of the form, e.g., a grid with rows and columns numbered and data fields highlighted.

But the focus of this article is on *custom* and *standardized* forms. Custom forms, of course, are designed to go with unique, user-written software. What I am calling *standardized* forms are designed to go with specific pieces of commercial software. If you buy an accounting program from the fictitious Ersatz Software, for example, and you know someone who sells forms for the Ersatz programs, you won't need to spend any time adapting the software to your forms or spend any legwork looking for stock forms that happen to be compatible with the software.

Custom Forms

If you absolutely must do things your own way down to the last detail, custom-designed and printed forms are for you. Many companies produce custom forms. These companies are found under "Business Forms" in the Yellow Pages. Minimum order quantities vary greatly. The companies listed in table 2 that do custom forms accept orders for minimums ranging from 1000 to 5000. Pricing varies with the com-

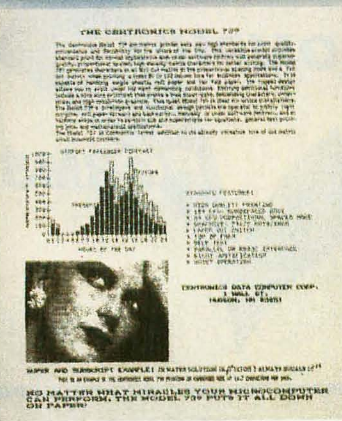
THE CENTRONICS 739. IT'S A LOT MORE THAN YOU'D EXPECT TO SELL FOR THE PRICE.



Inexpensive doesn't have to mean incomplete, and the quiet, dependable Centronics 739 is the classic example. It's complete in capability and because it's from Centronics you can expect it to perform just like the workhorse printers that have made Centronics a leader in the business for more than a dozen years. So when you shop for a desk-top printer and compare features, here's what you can expect from a 739:

CORRESPONDENCE QUALITY — Clear, high density characters plus right justification and proportional spacing that produce correspondence, direct mail, and other important documents that demand a "custom" quality appearance.

BUSINESS GRAPHICS — What good is a printer that can't print your technical business/management information? The 739 produces a range of graphics — from bar charts and curves to illustrative material — almost anything your computer can produce.



3-WAY PAPER HANDLING — Cut sheets for correspondence; roll paper for day-to-day operations; fan-folded forms for normal data printout.

DEPENDABILITY — You depend on your printer for hard copy of timely information and that means it must operate dependably. With Centronics reputation behind the 739, reliability is a foregone conclusion. More than 350,000 Centronics printers sold worldwide is the proof.

SERVICE — Someday you may need it. Where do you find it? With Centronics worldwide network of service locations it's not very far. And now, there are authorized Centronics sales and service dealers, and "walk-in" service centers in an expanding number of key cities throughout the U.S.

When it comes to printers, Centronics is the leading independent printer manufacturer — chosen by computer professionals in major industry brand preference studies. So when you look for an inexpensive printer don't settle for incomplete. Choose the Centronics 739. It comes complete with a commitment — to performance, dependability and service. See it at your Centronics dealer. Or write for information.

CENTRONICS® PRINTERS

Circle 70 on inquiry card.

Centronics Data Computer Corp.
One Wall Street, Hudson, New Hampshire 03051

plexity of the form. Many companies stress that it makes little sense to buy only 1000 custom forms because 5000 cost relatively little more—much of the cost lies in the unique design of the form.

Standardized Forms

A few companies are now offering forms to go with standard, commercial software packages for microcomputers. NEBS, Checks-to-Go, DFS, Moore, and Trinity are all active in this market. Your choice of a company might depend on whether you want to buy forms by telephone or mail, from your local computer or software dealer, or (with Moore, at least) from the company's own local office.

More likely, however, your choice will depend on which company has the forms for your commercial programs. Table 3 (page 204) lists the kinds of software for which the companies shown sold forms. Note that not all these companies identify forms the same way. Some companies list their standardized forms primarily by reference to software houses. Others refer primarily to computer companies: you tell them what kind of computer you use, and they tell you what forms they have for it. Some companies list standardized forms by a combination of software house and computer company. Since many computer companies sell software as well as hardware, you can't always be sure which forms company has exactly what you need.

Perhaps the wisest course is to contact all the companies or their local dealers and ask about your specific needs. Although table 3 lists the kinds of microcomputers and software for which various companies offer standardized forms, some of the companies have only recently entered the field. By the time you read this, the new entrants in the microcomputer forms market are likely to have added many new forms to their product lines. ■

Check-Mate
POB 103
Randolph, MA 02368
(617) 963-7694
Comments: Check-Mate sells only by direct mail and telephone. Its custom forms are limited to checks; its standard computer forms are for Radio Shack and Libra software only.

Checks-to-Go
8384 Hercules St.
La Mesa, CA 92041
(800) 854-2750
(800) 552-8817 (California residents only)
Comments: Checks-to-Go sells only by direct mail and telephone. Tell Checks-to-Go what kind of computer you have and you will receive a sample kit of its forms for your computer.

DFS Computer Forms
POB 643
Townsend, MA 01469
Comments: DFS has an extensive line of forms for existing microcomputer software and sells only through local dealers.

Moore Business Forms inc.
1205 North Milwaukee Ave.
Glenview, IL 60025
(800) 447-4700
(800) 322-4400 (Illinois residents only)
Comments: Moore sells forms through more than 600 of its own local sales offices around the United States. Check the Yellow Pages or call Moore's toll-free numbers to find out the name of your local dealer.

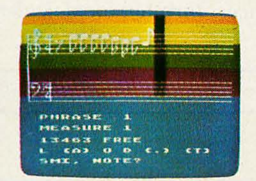
NEBS Computer Forms
78 Hollis St.
Groton, MA 01471
(800) 225-9550
(800) 922-8560 (Massachusetts residents only)
Comments: NEBS sells only by direct mail and telephone. On request, NEBS sends a helpful, cross-indexed Forms Selector Guide and a catalog with programmer's guides for each form.

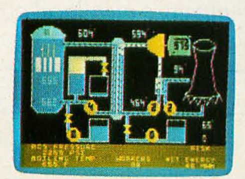
Trinity Forms Company
Micro Computer Forms Program
Carrollton, TX 75006
(800) 527-0625
(800) 492-5232 (Texas residents only)
Comments: Trinity sells through local dealers only. Contact Trinity on a toll-free number for the name of your local dealer. Trinity plans to introduce a large line of standard forms for many different microcomputer software packages.

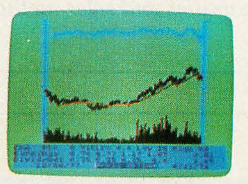
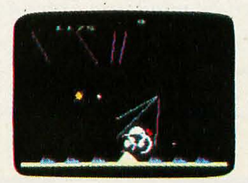
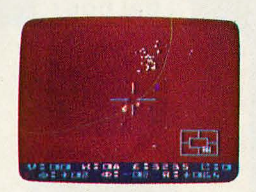
Table 1: *Some companies selling standardized or custom forms for microcomputers.*

THE GRAPHIC DIFFERENCE

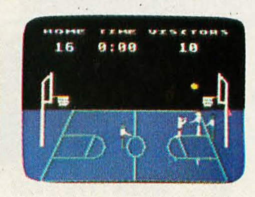
BETWEEN ATARI® COMPUTERS AND ALL OTHERS.











3.7 million reasons why the ATARI Home Computer is something to see.
The display screen used with our computers is composed of 192 horizontal lines, each containing 320 dots. Delivering color and luminosity instructions to each dot for a second requires 3.7 million cycles...a lot of work for the normal 6502 processor.

That's why the ATARI computer has equipped its 6502 with its own electronic assistant. It's called ANTIC, and it handles all the display work, leaving the 6502 free to handle the rest. What this means to you is uncompromisingly spectacular display capabilities without loss of computer power needed to carry out the demands of your program.

That's a quality you just don't find in ordinary personal computers. And it's one of the reasons some computer experts say that ATARI computers are so far ahead of their time.

There's more...which is what you'd expect from ATARI.

Language. The ATARI Personal Computer uses several programming languages to give the user maximum control of its extraordinary capabilities. PILOT, Microsoft BASIC* and ATARI BASIC are understood and spoken by the ATARI computer. You'll also find our Assembler Editor cartridge indispensable for machine language programming.



Sound. An ATARI computer has four sound generators, or voices, activated by a separate microchip. This leaves the principal microprocessor chips free to perform other tasks. And you can take full advantage of this capability which is designed for easy programming.

Change. ATARI Home Computers have been designed to make change and expansion easy. The ATARI computer has a modular operating system* that can be easily replaced as new technology develops. If you need it, memory expansion requires no more than inserting additional RAM modules.* And the ATARI ROM cartridge system also makes it easy to change languages. In short, your ATARI computer won't be obsoleted by future developments...*beause it already incorporates the future.*

Sharing. To learn more about the amazing capabilities of ATARI computers, visit your local computer store for a demonstration. Or send for our Technical User's Notes, intended for the serious programmer. They are only $27 and contain a lot more information about our computers' special capabilities than most companies could tell. See your ATARI dealer, or send $30 ($27 plus $3 postage and handling), payable to ATARI, to Technical User's Notes, c/o ATARI Customer Service, 1340 Bordeaux Avenue, Sunnyvale, CA 94086.

ATARI®

*ATARI 800™ computer only.

A Warner Communications Company

Circle 39 on inquiry card.

	Check-Mate	Checks-to-Go	DFS	Moore	NEBS	Trinity
How Sold	Mail and telephone	Mail and telephone	Local dealers	Local offices	Mail and telephone	Local dealers
CUSTOM FORMS	Checks only	Y		Y	N	Y
Minimum quantity	5000	5000		1000-2500		1000
CUSTOM CONTINUOUS LETTERHEAD	Y	Y		Y	Y	Y
Minimum quantity	1000	5000		1000-2500	500	1000
STANDARDIZED FORMS	Y	Y	Y	Y	Y	Y
Minimum quantity	1000	500		1000	500	500

Table 2: *Information about how six companies sell custom and standardized forms for microcomputers. Important considerations include minimum order quantities and sales methods—whether through a company's own local offices, through local dealers, or by mail and telephone.*

Financial Planning... from *SuperSoft*

SCRATCHPAD: SUPERSOFT'S ELECTRONIC WORKSHEET

ScratchPad is a user-interactive data modeling program suitable for financial planning or any general purpose modeling. Whether you are an executive, a researcher, or planning the family budget; you will find ScratchPad an invaluable tool in giving you the numeric correlations you need for sound decision making.

ScratchPad provides for labels and corresponding numeric data entries cross-referenced by row and column. Data entries are then defined as dependent variables in a user-created algebraic formula. You can now quickly see how changes in one or more variables affects all others.

ScratchPad includes the following

- Multiple screen splitting which allows two or more sections of the worksheet to be viewed simultaneously.
- Both immediate and deferred calculation modes allowing calculations to be either made as data is entered or deferred until later.
- Flexibility in entry and editing functions so that data can be entered or changed easily.
- Column widths are variable.
- Portions of the worksheet not currently being viewed can be quickly brought to the screen for either single or split screen viewing.
- Any portion of the worksheet can be printed as hardcopy at the user's discretion.

STATS-GRAPH: SUPERSOFT'S STATISTICAL DISPLAY PACKAGE

Stats-graph performs statistical analyses on user data and displays the results in graphic form.

Graphic formats include:

- Pie Graph
- Bar Graph
- Scatter Graph

Statistical Analyses include:

- Mean
- Median
- Minimum and Maximum values
- Standard Deviation
- Regression Analysis

Stats-graph is an easy-to-run, user-interactive program that presents valuable and often complex information in a concise and easily understood form.

DATA-VIEW: THE EXECUTIVE ORGANIZER

Data-view is an easy-to-use, free formatted system for organizing information. It can be used as an electronic filing cabinet, an automated date book, or a computerized listing device. Insertion and retrieval of information is both simple and quick. Data may be retrieved by file, string, or key word, and any type of information can be stored.

ScratchPad:	$200.00
Stats-graph:	$200.00
Data-view:	$200.00
Total Package:	$500.00
Manuals only:	$ 15.00

Software available for virtually all CP/M systems. Specify your system.

Available from fine dealers everywhere, or directly from:
SUPERSOFT, INC.
P.O. BOX 1628
CHAMPAIGN, IL 61820
217-359-2112 Telex: 270365
Technical Hot Line: 217-359-2691



U.K. and Europe:
DIGITAL DEVICES
134 LONDON ROAD
SOUTHBOROUGH, KENT
TUNBRIDGE WELLS
TN4, OPL
ENGLAND
Tel.: Tunbridge Wells (0892)37977/9
Telex: 95582

Japan:
ASR CORPORATION INTERNATIONAL
3-23-8 NISHI-SHIMBASHI, MINATO-KU
TOKYO 105
JAPAN
Tel: 03-437-5371
Telex: 0242-2723

First in Software Technology

Circle 366 on inquiry card.

Check-Mate	Checks-to-Go	Moore	NEBS	Trinity	DFS
		Accounting Plus			
		Allison Crain	Agency Computer Systems		Agency Computer Systems
	Alpha Micro				
	Anchor Systems				
			Antech		Antech
	Apple Computer	Apple Computer	Apple Computer		Apple Computer
			Applied Business Software		Applied Business Software
			Atlanta Business Computer		Atlanta Business Computer
			Balcones Computer Corp.		Balcones Computer Corp.
			Biss		Biss
	BPI Systems	BPI Systems		BPI Systems	
	Briareus				
			Broderbund Software		Broderbund Software
			Business Enhancement Compuservice		Business Enhancement Compuservice
	Cado	Cado			
		Canon U.S.A.			
			Cape Cod Computer		Cape Cod Computer
	Centurion-Warrex-Eds				
	Cimarron				
			CMS Software Systems		CMS Software Systems
			Coelco Software Systems		Coelco Software Systems
			COM Business Computer Systems		COM Business Computer Systems
			Compumax Associates		Compumax Associates
	Computax				
			Computerease Inc.		Computerease Inc.
			Computer Products International		Computer Products International
			Computer Research		Computer Research
			Computerware Inc.		Computerware Inc.
			Computhink		Computhink
	Continental Software		Continental Software		Continental Software
		Cromemco			
			CTI		CTI
			Custom Accounting		Custom Accounting
			Customation		Customation
			Custom Computing		Custom Computing
			D.B. Software		D.B. Software
			Dakin-5		Dakin-5
		Data General			
			Data Solutions		Data Solutions
		Data Train	Data Train		Data Train
			Data Universal		Data Universal
			Datavision		Datavision
			Davis-Lane		Davis-Lane
		DEC			
			Delphic Systems		Delphic Systems
			Delta Software		Delta Software
			Denver Software Company		Denver Software Company
	Designer Software				
	DIBS				
	Digilog				
	Digital Systems				
			Digital Tech		Digital Tech
			Duchess Enterprises		Duchess Enterprises
	Durango	Durango	Durango		Durango
	Dynabyte				
			Ecosoft		Ecosoft
			EDP Business Systems		EDP Business Systems
			Electronic Information Systems		Electronic Information Systems
			Fox Computer Systems		Fox Computer Systems
			Functional Solutions		Functional Solutions
			Glenn/Cliff Associates		Glenn/Cliff Associates
			Haland Data Systems		Haland Data Systems
			H & E Computronics		H & E Computronics
		Hewlett-Packard			
	IBM 5120				
	IBM Systems 32/34				

Table 3: *Hardware and software sources for which these companies produce standardized forms. Keep in mind that a company that produces forms for one program from a particular software house may not produce forms for all programs from that house. Furthermore, a company that produces forms for one computer from a certain manufacturer may not produce forms for every computer from that manufacturer. In addition, since some of these forms companies entered this market shortly before the research was done for this article, they may by now offer forms for more computers and more software.*

Check-Mate	Checks-to-Go	Moore	NEBS	Trinity	DFS
			ICM Computer Systems		ICM Computer Systems
			Idea Micro Design		Idea Micro Design
	IMS				
			Info Designs		Info Designs
	Insoft				
			Interactive Operations Associates		Interactive Operations Associates
			International Computer Service		International Computer Service
			International Data Tech		International Data Tech
			Key Systems		Key Systems
			Legler Systems		Legler Systems
			Lenz, Masterson & Associates		Lenz, Masterson & Associates
Libra	Libra	Libra			
			Mark/Donn Associates		Mark/Donn Associates
			George Matyjewica & Company		George Matyjewica & Company
	MCBA				
	MCS				
			Medfield Computer Software		Medfield Computer Software
			Microcomputer Consultants		Microcomputer Consultants
			Micro-Management		Micro-Management
			Midwest Data Services		Midwest Data Services
			Mitex		Mitex
			Montour Computer Systems		Montour Computer Systems
		Moore			
			Murray Jones Murray Engineers		Murray Jones Murray Engineers
	NEC	NEC			
	North Star				
		Open Systems			
	Osborne				
	Peachtree	Peachtree		Peachtree	
			P.G. & J.		P.G. & J.
			P K Systems		P K Systems
	R & B Systems				
Radio Shack	Radio Shack	Radio Shack	Radio Shack		
			Realistic Computing of Georgia		Realistic Computing of Georgia
			G.A. Rock Systems Group		G.A. Rock Systems Group
			Rocky Mountain Software		Rocky Mountain Software
			RTG Data Systems		RTG Data Systems
			S & M Systems		S & M Systems
			Score		Score
		Serendipity Software			
	Shasta				
			Small Business Systems Group		Small Business Systems Group
			Small Systems Software		Small Systems Software
			Software Services		Software Services
			Software Technology for Computers		Software Technology for Computers
	Structured Systems	Structured Systems			
			Synergetic Computer Systems		Synergetic Computer Systems
	Systems Plus			Systems Plus	
			Tailored Data		Tailored Data
			Taranto & Associates		Taranto & Associates
			Targhee Software Engineering		Targhee Software Engineering
			TBSB		TBSB
	TCS Software	TCS Software		TCS Software	
		Texas Instruments			
			The Bottom Shelf		The Bottom Shelf
			The Software Exchange		The Software Exchange
		The Software Shoppe			
			The Systems Shop		The Systems Shop
	Timberline				
			Utility Computing Service		Utility Computing Service
	Vandata		Vandata		Vandata
	Vector Graphic				
	Wang				
			Westware		Westware
			Woodbury Computer Associates		Woodbury Computer Associates
			Xtra Soft		Xtra Soft

Base 2 Printer

Walter Jeffries
RFD 1
Readfield, ME 04355

Recently, after considering it for quite awhile, I added a printer to my system. My choice was the Base 2 printer, which I use with an Exidy Sorcerer with 32K bytes of RAM (random-access read/write memory). I bought the printer used for $470, complete with most of its options (tractor feed, graphics option, and expanded character buffer). Parts of this article may not apply to Base 2 printers that lack these options.

Construction

This compact printer measures 7.5 by 24.5 by 35.6 cm (3 by 11 by 15 inches) and is constructed of aluminum, which makes the printer surprisingly heavy for its size. The aluminum chassis acts as a heat sink for the large-scale integrated (LSI) circuits, making a fan unnecessary if the printer has an unimpeded airflow. Designed around the 8085 microprocessor and other LSI chips, the printer has few components but great flexibility. Behind the tractor mechanism is a removable panel that provides access to two erasable programmable read-only memories (EPROMs).

One EPROM contains the printer's program and the standard character set, consisting of 96 ASCII characters. The other EPROM can contain auxiliary character sets; it does not come standard with the printer. The paper inlet is located in the bottom of the printer, and the friction feed mechanism is located inside. In the upper left-hand corner of the printer's back panel is the power switch. Also on the back panel are the three interface connectors, power inlet, mode switches, and the reset/self-test switch. On the front panel are the formfeed (FF) and unit-select switches.

Interfaces

The Base 2 printer has three interface connectors that support four popular interfaces: RS-232, 20-milliampere (mA) current loop, Centronics parallel, and IEEE-488. You select the interface mode by using two switches of an eight-position miniature DIP (dual-inline package) switch located under the power switch. The next four switches set the default line length from any of five of the six line densities. The remaining two switches determine the "pinout" (lines assigned to the socket pins) for the serial interfaces. Also on the back panel is the data rate/unit-number switch, which consists of a 16-position thumb-wheel switch. In the serial mode this switch determines one of 15 data rates ranging from 75 to 9600 bits per second. In the IEEE-488 interface mode this switch acts as the unit-number switch. In the parallel mode this switch is not used.

An additional mode recommended for the TRS-80 uses the parallel interface and a line length of 80

At a Glance

Name
Base 2 printer

Use
Medium-quality printer

Manufacturer
Base 2 Inc.
POB 3548
Fullerton, CA 92634
(714) 533-0111

Dimensions
7.5 by 24.5 by 35.6 cm (3 by 11 by 15 inches)

Price
$699

Hardware Needed
Host computer with one of four interfaces: RS-232, 20-mA current loop, Centronics parallel, IEEE-488

Software Needed
Appropriate driver for interface

Hardware Options
Tractor feed, paper holder, graphics option, expanded buffer

Features
Print speed: 100 cps bidirectional. Formfeed speed: 1.5 inches per second. Six character densities with elongated printing. Standard 96 ASCII characters in 5 by 7 dot-matrix font. Nine additional user-defined character fonts.

Documentation
74-page paperback

Audience
Computer hobbyist desiring a flexible, inexpensive printer

How to turn your HP-41 into a handheld computer.





Introducing the Hewlett-Packard Interface Loop.

Starting today, your HP-41C or HP-41CV can be more than just a great little calculator. It's a great little computer, capable of controlling a quickly-expanding family of peripherals.

The new Hewlett-Packard Interface Loop (HP-IL) makes it all possible. HP-IL is an easy-to-use, low-cost interfacing system, specifically designed for battery-operable devices.

The Interface Module and Peripherals.

At the heart of the system is the Interface Module, which plugs into any one of four HP-41 ports. You can control up to 30 peripherals, using only one port in your HP-41 calculator.

One of the key HP-IL peripherals is the new Digital Cassette Drive. This battery-operable device provides an incredible 131,000 bytes of mass memory.

Another work-saving HP-IL peripheral is the new, battery-operable Thermal Printer/Plotter with enhanced formating options and graphics.

This is just the beginning.

There are many more HP-IL products on the way. And they're all designed to provide the versatility and adaptability you expect from HP. You see, Hewlett-Packard is committed to a very big idea: small devices talking to each other, giving you big system capabilities – at small system prices!

For details and the address of your nearest dealer, CALL TOLL FREE: 800 547-3400, Dept. 276J, except Hawaii/Alaska. In Oregon, call 758-1010, or write Hewlett-Packard, Corvallis, OR 97330, Dept. 276J. TTY users (503) 758-5566.

611/18.

When performance must be measured by results.



HEWLETT PACKARD

HP-IL

Circle 178 on inquiry card.

ASCII	Hexadecimal	Decimal	Code	Operation
CTL I	09	09	HT	Horizontal Tab
CTL J	0A	10	LF	Linefeed
CTL K	0B	11	VT	Vertical Tab
CTL L	0C	12	FF	Formfeed
CTL M	0D	13	CR	Carriage Return
CTL N	0E	14	SO	Elongated Characters
CTL Q	11	17	X-ON	Selects unit online
CTL S	13	19	X-OFF	Deselects unit offline

Table 1: *The control codes of the Base 2 printer.*

characters, with automatic linefeed (LF) on receipt of a carriage return (CR).

Power Supply

My printer came wired for 110 volts of alternating current, but it can easily be rewired for 210 volts. Written directions and diagrams are in the operator's manual. Since the stepping motors are direct current (DC) and independent of the line frequency, the printer does not need to compensate for frequencies of 50 or 60 hertz (Hz).

Circle 153 on inquiry card. →

Manual Control

The Base 2 printer's front panel consists of a unit-select switch and a formfeed switch. When the unit-select switch is on, the formfeed switch causes the printer to eject paper to the top of the next form (default form length is 66 lines per page). When the switch is off, the formfeed switch causes the paper to advance at a rate of 1.5 inches per second.

In the upper right-hand corner of the printer's back panel is the reset/self-test switch. When toggled to the left, this switch resets the printer to its default mode. When the reset/self-test switch is toggled to the right, the printer prints a line of characters using the present mode. The self-test switch allows testing the printer independently of the host computer.

Software Control

Two sets of software controls have functions that overlap to a slight degree. One set consists of "control codes" (table 1); the other set consists of "function codes" (table 2). To take effect, the function codes must be prefixed by an ESC (ASCII 27). Some of the function codes must be followed by data, as when setting tabs.

The Base 2 printer supports six character densities (64, 72, 80, 96, 120, and 132 characters per line), as well as elongated characters (10 dots wide rather than 5) in all character densities.

The standard character set contains 96 ASCII characters in a 5 by 7 dot-

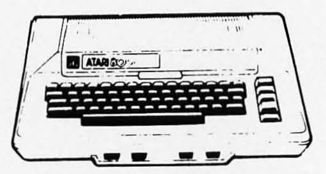
ASCII	Hexadecimal	Decimal	Function
J	4A	74	General printer reset
H	48	72	Unit select
I	49	73	Unit deselect
j	6A	106	Enable unidirectional printing
k	6B	107	Enable bidirectional printing
R	52	82	Enable 1920 character buffer
S	53	83	Disable 1920 character buffer
5	35	53	Disable print on buffer full
6	36	54	Enable print on buffer full
7	37	55	Enable auto LF following CR
8	38	56	Disable auto LF following CR
B	42	66	Enable CR recognition
C	43	67	Disable CR recognition
D	44	68	Enable LF recognition
E	45	69	Disable LF recognition
V	56	86, n1...n16	Set horizontal tabs
X	58	88	Reset horizontal tabs
Y	59	89, n1...n10	Set vertical tabs
a	61	97	Reset vertical tabs
@	40	64	Enable elongated characters
A	41	65	Disable elongated characters
T	54	84, n	Set form length to n lines
9	39	57, n	Set auto FF count
:	3A	58	Enable auto FF
;	3B	59	Disable auto FF count
F	46	70, n	Set eject to n lines
G	47	71	Eject
d	64	100	Set line length to 64 chars.
0	30	48	Set line length to 72 chars.
1	31	49	Set line length to 80 chars.
2	32	50	Set line length to 96 chars.
3	33	51	Set line length to 120 chars.
4	34	52	Set line length to 132 chars.
b	62	98, n	Set vertical line density
c	63	99, data	Enable and send graphics
K	4B	75, data	Load user-defined characters
L	4C	76	Enable user-defined chars.
M	4D	77	Enable Standard ASCII chars.
O	4F	79	Enable optional chars. 1
P	50	80	Enable optional chars. 2
Q	51	81	Enable optional chars. 3
e	65	101	Enable optional chars. 4
f	66	102	Enable optional chars. 5
g	67	103	Enable optional chars. 6
h	68	104	Enable optional chars. 7
i	69	105	Enable optional chars. 8

Table 2: *The function codes of the Base 2 printer. All function codes must be preceded by an ASCII <ESC> (escape, hexadecimal 1B, decimal 27) in order to take effect.*

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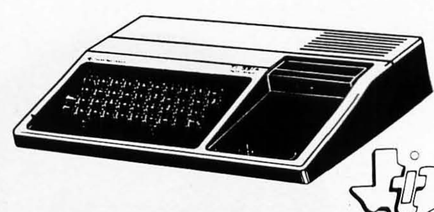
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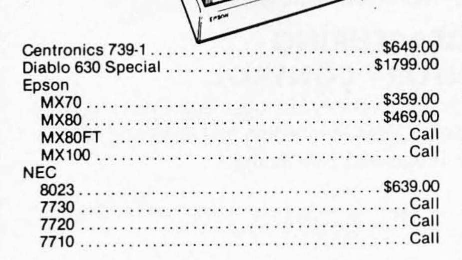
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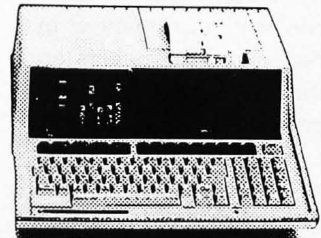
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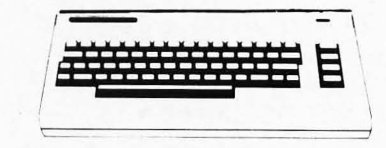
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matrix font. With software, you can define 96 other characters as an alternate character set. Up to eight other character sets can be contained in a 2732 EPROM, or four in a 2716 EPROM. A function code selects each of the 10 character sets. These extra character sets, especially the user-defined set, allow for special character sets, for example, APL characters, math symbols, and foreign alphabets.

The expanded buffer allows storage within the printer of a full screen (1920 characters). The buffer contents are printed either when the buffer is full or the print-buffer function code is received. The print on buffer full can be optionally disabled with a function code.

The graphics feature provides six horizontal densities up to 99 dots per inch and a constant vertical density of 72 dots per inch. Table 3 shows the character set in different densities. To use the graphics mode, you send the graphics-mode-enable function code followed by a full line of graphics data. The graphics data consist of bytes in which the lower 7 bits control the seven wires in the print head. The printer automatically prints the line of graphics upon receiving a full line of data. Since the printer does not linefeed automatically in the graphics mode, you must send an LF after each line of data. Figure 1 shows a printout of my name in script, produced by using the graphics mode.

Documentation

The documentation for the Base 2 printer is well done. It consists of a single 74-page *Operator's Reference Manual* that is divided into five sections plus appendixes. The sections cover installation, operation, internal specifications, and software control. Each control code and function code has a complete written description followed by a demonstration program in BASIC. The appendixes cover the hardware, providing full schematic diagrams and component layouts for the logic boards, as well as the parts lists.

Disaster and Recovery

After I wrote the first draft of this article, disaster struck at a most inconvenient time (couldn't Murphy have waited?). I had used my computer to write my term papers in school and had saved the papers on tape. When the time came to print the papers and pass them in, the printer blew a fuse. Okay, I thought, no problem. Just a fuse. Having noticed that the lights had flickered earlier, I thought it was probably just a power surge. I made sure that none of the mechanical parts had stuck, and then I inserted a new fuse. That blew immediately. My printer was not under warranty. Besides, I needed the printer *now*; I could not afford to wait six weeks for the company to fix it. Well, everything was not against me. With the help of the *Operator's*

```
64 characters per line:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Elongated:
! "#$%&'()*+,-./0123456789:;<=>

72 characters per line:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Elongated:
! "#$%&'()*+,-./0123456789:;<=>?@AB

80 characters per line:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Elongated:
! "#$%&'()*+,-./0123456789:;<=>?@ABCDEF

96 characters per line:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Elongated:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLM

120 characters per line:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Elongated:
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ

132 characters per line:
* !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
Elongated
 !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_
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Table 3: *Printouts of the Base 2 printer character set. The densities range from 64 characters per line to 132 characters per line.*

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Figure 1: *A printout produced using the Base 2 printer's graphics mode. The printer renders the author's name in script.*

Reference Manual and a multimeter, I was able to determine that the diodes in one of the bridge rectifiers of the power supply had blown, creating a short circuit. The parts were standard; the night before my papers were due, I got the parts and fixed the printer.

This experience put quite a strain on my nerves, but it did teach me that the printer is quite simple to dismantle and repair.

Conclusions

The following conclusions can be made about the Base 2 printer. It is rugged and is backed up with a good manual listing all the parts and containing schematics and layouts.

The printer's format is very flexible and can be changed under software control or, to a lesser degree, by hand. It requires a driving program in the host computer to do the handshaking.

The printer can support as many as 10 character fonts: standard 96-character ASCII, user-defined, and eight more fonts, all in EPROM.

It accommodates four major interfaces: RS-232, 20-mA current loop, Centronics parallel, and IEEE-488. The printer provides high-resolution graphics.

The print rate is 100 characters per second, with bidirectional printing. Both hardware and software are well documented with many diagrams and examples. ■


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The Fill Forms System is composed of three CP/M-based programs. The first, FFGRID-1, is used to determine the line and column position for each data field. The next, FFTABL-1, is used to build a control table that is used by the third program, FFORM-1, for data entry and forms printing. These programs are relatively simple and, best of all, easy to use.

Form designers have been known to ignore the fact that typewriters and printers are generally unable to handle forms with unusual line spacing.

Each of these programs is written in Microsoft BASIC and is designed for use on a CP/M-based system (CP/M versions 1.4 through 2.2).

Editor's Note: *Copies of these programs, on either 8-inch single-density CP/M disks or 5¼-inch single-density disks for North Star CP/M users complete with instruction manual can be obtained for $20 from Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 91367. Programs with the enhancements mentioned in the article are also available.*

Determining Field Positions

The idea behind the system is to establish the line and column position for each data field to be printed on the form, then enter the data and print it in the proper position.

Field positions may be determined by measuring the number of lines in the form and finding the width by counting the spaces from the left side of the form (see figure 1). Once line position 1 and column position 1 are established as reference points, all other field locations can easily be determined—if you count correctly.

This method works fine for a form with a few fields, but when there are a number of fields, it is better to draw a grid on the form and then determine the field positions from the intersections of the horizontal and vertical lines of the grid.

Gridding the Form

The FFGRID-1 program is used to produce a grid on a form (see listing 1). The program prints a row of col-

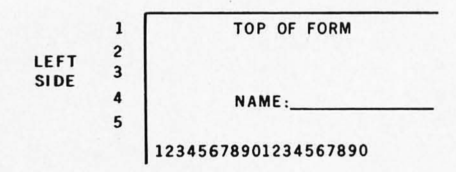
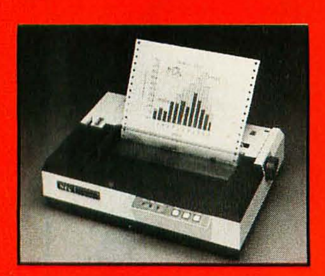


Figure 1: *Each field position is determined by its particular reference points. The form is divided into numbered rows and columns. In this example, the data for the NAME field should be placed on line position 4 and start in column position 14.*

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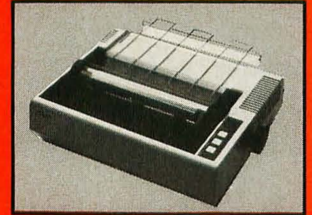


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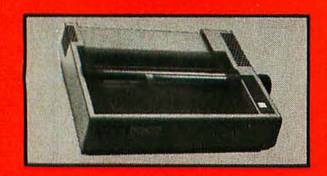


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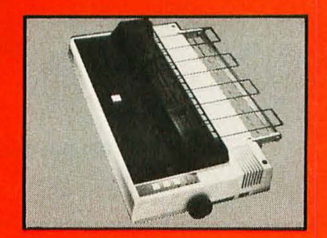
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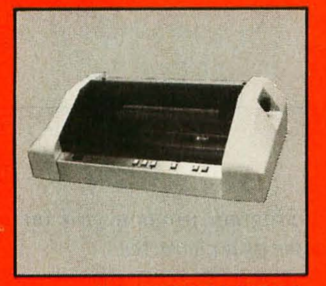
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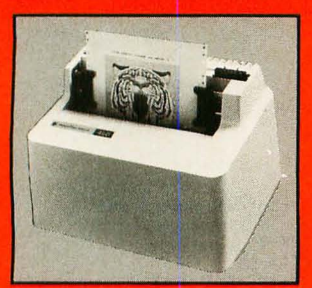
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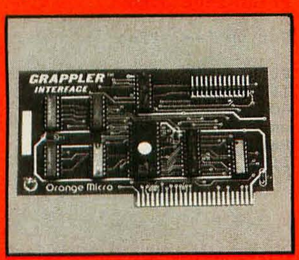
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umn positions across the top of the form and on every tenth line. It also prints each line position on both edges of the form as well as horizontal and vertical grid lines. Since plus and minus characters are used, the grid intersections are at the center of a character rather than to the left and under it.

The program requires that you enter only the form size: the number of lines per page and the width in columns. After you position the form, the program prints an asterisk (*) in line position 1 and column position 1. You can then reposition the form if necessary. Any number of attempts at repositioning may be tried, since

Text continued on page 228

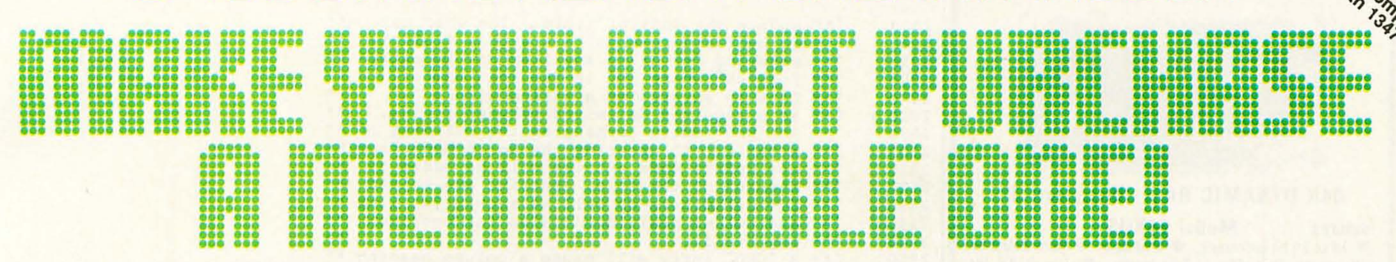
Listing 1: *The FGRID-1 program prints a grid on your form. Each plus or minus character denotes the center of a character.*

```
10      '****************************************
20      '**                                    **
30      PRINT:  PRINT                         '**
40      PRINT "         FGRID-1.BAS"          '**
50      PRINT "      Form Grid Program"       '**
60      PRINT "Copyright 1981 by Elliam Assoc."'*
70      '**                                    **
80      '** This program prints a grid on a    **
90      '** form.                              **
100     '**                                    **
110     '****************************************
120     '
500     PRINT:  INPUT "Form length: ",L%
510     INPUT " Form Width: ",W%
520     PRINT:  INPUT "Position Form c/r ",X$
530     LPRINT "*";                                       'Print alignment mark
540     PRINT
550     INPUT "OK (Y or N): ",X$                          'OK ?
560     IF X$="Y" GOTO 1020                               'Its ok
570     LPRINT CHR$(13);                                  'Print c/r only
580     GOTO 520                                          'Try again
590     '
1000 'BUILD COLUMN NUMBER LINE
1010    '
1020    HORZ$="":        FOR K%=1 TO W%                   'Build a column
1030            A$=MID$(STR$(K%),2)                       'number print line
1040            HORZ$=HORZ$+RIGHT$(A$,1)
1050    NEXT
1060    '
1200 'BUILD GRID LINE
1210    '
1220    DP$="": DASHPLUS$="----+"                         'Build grid line
1230    FOR K%=1 TO W%/5+1
1240            DP$=DP$+DASHPLUS$
1250    NEXT
1260    DP$=LEFT$(DP$,W%)
1270    '
1300 'PRINT TOP COL NUM LINE
1310    '
1320    LPRINT MID$(HORZ$,2)
1330    J%=1
1340    '
1400 'PRINT GIRD LINES
1410    '
1420    FOR K%=2 TO L%-1
1430            A$=MID$(STR$(K%),2)
1440            LPRINT A$;                                'Print line number
1450            IF J%=0 GOTO 1500
1460            DPLUS$=MID$(DP$,LEN(A$)+1)                'Set up '-+' line
1470            DPLUS$=LEFT$(DPLUS$,LEN(DPLUS$)-LEN(A$))
1480            LPRINT DPLUS$;A$                          'Print grid line &
1490            GOTO 1520                                 'line number on rt.
1500            GOSUB 3020                                'Go build col num line
1510            LPRINT HZ$;A$                             'and print it
1520            J%=J%+1:        IF J%=10 THEN J%=0        'Reset for every 10th
1530    NEXT                                              'line
1540    '
2000 'PRINT BOTTOM COL NUM LINE
2010    '
2020    A$=MID$(STR$(K%),2)
2030    GOSUB 3020
2040    LPRINT A$;HZ$;A$
2050    END
2060    '
3000 'SETUP COL NUM LINE
3010    '
3020    HZ$=MID$(HORZ$,LEN(A$)+1)
3030    HZ$=LEFT$(HZ$,LEN(HZ$)-LEN(A$))
3040    RETURN
```

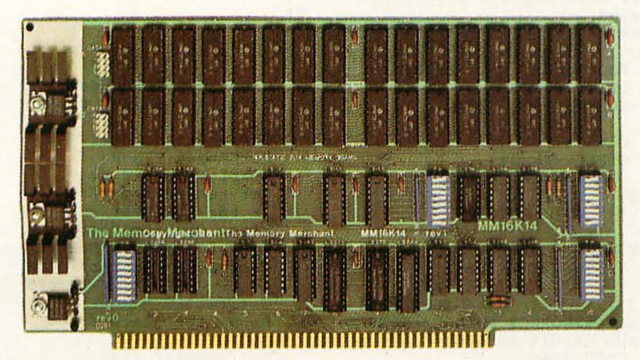
Listing 2: *Using the positions determined from the gridded form, the FFTABL-1 program can develop a control table that displays the field name for each piece of data, sets the maximum field length, and enters the exact line and column position for each data field.*

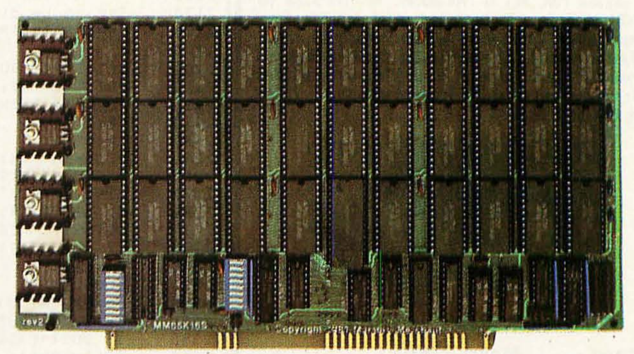
```
10         '****************************************
20         '**                                    **
30         PRINT:  PRINT                         '**
40         PRINT "         FFTABL-1.BAS"         '**
50         PRINT "   FillForm Table Program"     '**
60         PRINT "Copyright 1981 by Elliam Assoc."'*
70         '**                                    **
80         '** This program Builds or Updates a   **
90         '** Control table file that is used    **
100        '** with FFORM-1.BAS                   **
110        '**                                    **
120        '**         MICROSOFT BASIC            **
130        '****************************************
140        '
150        'Set for 100 records
160        '
500 'INITIALIZATION
510        '***********************************************
520        '** Dimension arrays, Set flags and Initialize**
530        '** variables.                               **
540        '***********************************************
550        '
560        DIM LCL$(3),LNE$(100),COL$(100),LN$(100),FLDNA$(100)
570        FALSE%=0:        TRUE%=-1
580        NOREC%=0:                                          'Max Number of Records
590        CTFLG%=FALSE%                                      'Record counter flag
600        RFL%  =FALSE%                                      'Re-enter flag
610        UDT%  =FALSE%                                      'File read flag
620        ERFLG%=FALSE%                                      'Error flag
630        DEF FNL$(Q$)=LEFT$(A$,1)
640        CHD1$="Item  Ln  Col  Fld"
650        CHD2$=" No    No   No  Len   Field Name"
660        INV$ ="Invalid ":         FIL$=""
670        LCL$(1)="Line No.":     LCL$(2)="Column No.":   LCL$(3)="Length"
680        CMDS$(1)="VALID COMMANDS":       CMDS$(2)=" "
690        CMDS$(3)="D# - Deletes item no. #"
700        CMDS$(4)="I# - Allows record to be inserted at item no. #"
710        CMDS$(5)="R# - Allows new item to replace item no. #"
720        CMDS$(6)="L  - Lists all items"
730        CMDS$(7)="L# - Lists item no. #"
740        CMDS$(8)="L#-# - Lists Range of Items"
750        '
1000 'COMMAND MODE
1010       '***********************************************
1020       '** This section directs the control of the   **
1030       '** program.                                  **
1040       '***********************************************
1050       '
1060       PRINT
1070       INPUT "Build Table, Update Table, List Table or END (B, U, L or E): ",A$
1080       IF FNL$(Q$)="B" GOTO 1130
1090       IF FNL$(Q$)="U" GOTO 1140
1100       IF FNL$(Q$)="L" GOTO 1160
1110       IF FNL$(Q$)="E" GOTO 7050
1120       GOTO 1060
1130       GOSUB 2190:      GOTO 1050                         'Build Mode
1140       GOSUB 1560:      IF A$="<" GOTO 1050               'Read table file
1150       GOSUB 4090:      GOTO 1050                         'Update Mode
1160       GOSUB 1560:      IF A$="<" GOTO 1050               'Read table file
1170       GOSUB 5860:      GOTO 1050                         'List file
1180       '
1500 'READ CONTROL TABLE FILE
1510       '***********************************************
1520       '** This routine reads the sequential control **
1530       '** table file and places each field in the   **
1540       '** appropriate array for updating.           **
1550       '***********************************************
1560       '
1570       IF UDT% THEN RETURN                                'If file has been read ret
1580       INPUT "Drive (A or B): ",DRV$                      'Get drive for file
1590       IF DRV$="<" THEN RETURN
1600       IF DRV$<>"A" AND DRV$<>"B" GOTO 1580               'NOTE: <filename>
1610       INPUT "Enter Table Name: ",FIL$                    'extension set to 'TBL'
1620       IF FIL$="<" GOTO 1580
1630       OPEN "I",1,DRV$+":"+FIL$+".TBL"                    'Open sequential file
1640       PRINT "Reading {";FIL$;"} Table"                   'Display message
1650       FOR I%=1 TO 1000                                   'Read Table File
1660               IF EOF(1) GOTO 1710
1670               INPUT #1,LNE$(I%),COL$(I%),LN$(I%)
1680               LINE INPUT #1,A$
1690               A$=MID$(A$,2):  FLDNA$(I%)=LEFT$(A$,LEN(A$)-1)  'Strip quotes
1700       NEXT                                                'from string
1710       NOREC%=I%-1                                        'Number of records
1720       PRINT:  PRINT NOREC% "Table Entries Read"
1730       PRINT
1740       UDT%=TRUE%                                         'Set file read flag
1750       CLOSE #1                                           'Close file
1760       RETURN
1770       '
2000 'BUILD CONTROL TABLE
2010       '***********************************************
2020       '** This routine builds and also is used to   **
```

Listing 2 continued on page 226



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Circle 233 on inquiry card.

Listing 2 continued:

```
2030     '** update the control table.  The user may    **
2040     '** go back and re-enter a previous field by   **
2050     '** entering '<' or to any item no. by enter-  **
2060     '** ing '<N' where 'N' is the item number.     **
2070     '** Data is entered as a string with a ','     **
2080     '** as a required delimiter between fields.    **
2090     '** An 'END' entry terminates the building of  **
2100     '** a table.  If entering the Build Mode from  **
2110     '** the Update Mode entries will be added to   **
2120     '** the end of the file.  Entries are edited   **
2130     '** for delimiters as well as sequential line  **
2140     '** and column positions - also for overlapp-  **
2150     '** ing fields.                                **
2160     '** A 'CHD' entry will cause a column heading  **
2170     '** to be displayed.                           **
2180     '***********************************************
2190
2200     PRINT "<< BUILD MODE >>":        PRINT
2210     PRINT CHD1$:    PRINT CHD2$                        'Display Column Heading
2220     IF UDT% THEN C%=NOREC%: GOTO 2240                  'If file read set counter
2230     C%=0
2240     C%=C%+1:          C1%=C%                           'Increment counter
2250     RFL%=FALSE%:      CTFLG%=TRUE%                     'Set/Reset flags
2260     PRINT RIGHT$("    "+STR$(C%),4)+". ";              'Display Record No.
2270     LINE INPUT "",A$                                   'Get record from Kbrd
2280     IF LEFT$(A$,1)<>"<" GOTO 2370                      'Ck for re-enter
2290     CTFLG%=FALSE%                                      'Reset counter flag
2300     IF LEN(A$)<>1 THEN GOTO 2330                       'Test for record number
2310     C%=C%-1:          IF C%<1 THEN C%=1                'Decrement counter
2320     GOTO 2260                                          'Go re-enter Prev record
2330     C%=VAL(MID$(A$,2)):      IF C%<1 THEN C%=1         'Get record number
2340     IF UDT%=TRUE% AND C%>NOREC% THEN C%=NOREC%         'Range test record no.
2350     IF UDT%=FALSE% AND C%>C1% THEN C%=C1%              '  "     "     "    "
2360     RFL%=TRUE%:       GOTO 2260                        'Set reenter flag
2370     IF A$="CHD" THEN PRINT CHD1$:   PRINT CHD2$:      GOTO 2260
2380     IF A$="END" THEN RETURN                            'End of entries
2390     FOR K%=1 TO 3:  J%=INSTR(A$,",")                   'Test for Field
2400             IF J%<>0 GOTO 2420                         ' delimiters
2410             PRINT INV$;"delimiter": GOTO 2260          'Error message
2420             B$(K%)=LEFT$(A$,J%-1)                      'Break up entry string
2430             A$=MID$(A$,J%+1)
2440     NEXT
2450     B$(4)=A$                                           'Field name
2460     FOR K%=1 TO 3                                      'Test for numeric
2470             FOR J%=1 TO LEN(B$(K%))
2480             IF MID$(B$(K%),J%,1)=>"0" AND MID$(B$(K%),J%,1)<="9" GOTO 2510
2490             PRINT INV$;                                'Display Error msg
2500             PRINT  LCL$(K%):          GOTO 2260        'Field not Numeric
2510             NEXT
2520     NEXT
2530     IF EDFLG% THEN GOSUB 3260:      IF ERFLG% GOTO 2260     'Go Edit
2540     IF C%=1 GOTO 2560                                  'Skip if first record
2550     GOSUB 3060:       IF ERFLG% GOTO 2260              'Go Edit against Prev
2560     LNE$(C%)=B$(1): COL$(C%)=B$(2)                     'Store fields
2570     LN$(C%)=B$(3):  FLDNA$(C%)=B$(4)                   '  "     "
2580     UDT%=TRUE%                                         'Set no-read flag
2590     IF CTFLG% THEN NOREC%=NOREC%+1                     'Increment Max rec ctr
2600     IF RFL% THEN C%=C1%-1:   RFL%=FALSE%               'Reset Counter & flag
2610     IF EDFLG% THEN RETURN ELSE GOTO 2240
2620     '
3000 'CHECK AGAINST PREV RECORD
3010     '***********************************************
3020     '** Test line numbers and column positions to **
3030     '** prevent backward  movement and overlapping**
3040     '** fields.                                   **
3050     '***********************************************
3060     '
3070     ERFLG%=FALSE%                                      'Reset Error flag
3080     IF VAL(B$(1))=>VAL(LNE$(C%-1)) GOTO 3110           'Test line number
3090     PRINT "Line no.(";B$(1);") Less then Previous Line No.(";LNE$(C%-1);")"
3100     GOTO 3390                                          'Display error message
3110     IF VAL(B$(1))>VAL(LNE$(C%-1)) GOTO 3360            'Test for overlapping
3120     IF VAL(COL$(C%-1))+VAL(LN$(C%-1))<VAL(B$(2)) GOTO 3140  'fields
3130     PRINT "Overlapping fields":       GOTO 3390        'Display error message
3140     GOTO 3360                                          'Go finish test
3150     '
3200 'CHECK AGAINST NEXT RECORD
3210     '***********************************************
3220     '** Test line numbers and column positions to **
3230     '** prevent backward movement and overlapping **
3240     '** fields.                                   **
3250     '***********************************************
3260     '
3270     IF C%=NOREC%+1 THEN RETURN                         'No test if appending
3280     IF C%=NOREC% AND EDFLG% THEN RETURN                'No test if repl last
3290     ERFLG%=FALSE%                                      'Reset Error flag
3300     IF VAL(B$(1))<=VAL(LNE$(C%+1)) GOTO 3330           'Test line number
3310     PRINT "Line no.(";B$(1);") Greater then Next Line No.(";LNE$(C%+1);")"
3320     GOTO 3390                                          'Display error message
3330     IF VAL(B$(1))<VAL(LNE$(C%+1)) GOTO 3360            'Test for overlapping
3340     IF VAL(B$(2))+VAL(B$(3))<VAL(COL$(C%+1)) GOTO 3360      'fields
3350     PRINT "Overlapping fields":       GOTO 3390        'Display error message
3360     FOR K%=1 TO 3:  IF B$(K%)="0" GOTO 3380            'Test for zero
3370     NEXT:    RETURN
3380     PRINT LCL$(K%);" can not be Zero"                  'Display error message
3390     ERFLG%=TRUE%:     RETURN                           'Set Error flag
3400     '
4000 'UPDATE
4010     '***********************************************
4020     '** In the Update Mode records may be Insert- **
4030     '** ed, Replaced, Deleted and Listed.  Enter  **
4040     '** the code letter for the function and the  **
```

Listing 2 continued:

```
4050     '** Item No. The 'L' (list) by itself will      **
4060     '** list the whole Control Table.  'L#' lists **
4070     '** Item #.  'L#-#' lists a range of item Nos.**
4080     '***********************************************
4090     '
4100     PRINT:  PRINT "<< UPDATE MODE >>":       PRINT
4110     INPUT "Insert, Replace, Delete, List, END or ?(I#,R#,D#,L#-#,E or ?): ",A$
4120     EDFLG%=FALSE%:  PRINT                              'Reset Edit flag
4130     IF FNL$(Q$)="E" THEN RETURN                        'Done updating
4140     EDFLG%=TRUE%:    DPB$="D"                          'Set Edit flag
4150     CMD$=FNL$(Q$):   A$=MID$(A$,2)                     'Strip cmd char
4160     FOR K%=1 TO 5
4170             IF CMD$=MID$("IRDL?",K%,1) GOTO 4190       'Valid entry?
4180     NEXT:    GOTO 4110                                 'Go redo
4190     '          INSR REPL DELT LIST   ?
4200     ON K% GOSUB 4470,4740,5060,5450,4240
4210     PRINT:   GOTO 4110
4220     '
4230 'LIST COMMANDS
4240     '
4250     FOR K%=1 TO 8:  PRINT CMDS$(K%):         NEXT
4260     RETURN
4270     '
4400 'INSERT ITEM
4410     '***********************************************
4420     '** Records are always inserted ahead of the  **
4430     '** item number used.  Records are moved up to**
4440     '** room to insert the new record.  The Max    **
4450     '** record counter is incremented.             **
4460     '***********************************************
4470     '
4480     LNENO%=VAL(A$): IF LNENO%>0 GOTO 4500              'Test for valid Rec #
4490     GOTO 5570
4500     IF LNENO%>NOREC% THEN LNENO%=NOREC%+1:  GOTO 4570       'Append
4510     FOR K%=NOREC% TO LNENO% STEP-1                     'Open up space for rec
4520             LNE$(K%+1)=LNE$(K%)                        'Move line number
4530             COL$(K%+1)=COL$(K%)                        'Move column position
4540             LN$(K%+1)=LN$(K%)                          'Move Field length
4550             FLDNA$(K%+1)=FLDNA$(K%)                    'Move Field Name
4560     NEXT
4570     C%=LNENO%                                          'Set Counter
4580     GOSUB 2260                                         'Go get entry
4590     NOREC%=NOREC%+1:RETURN                             'Increment Max rec ctr
4600     '
4700 'REPLACE ITEM
4710     '***********************************************
4720     '** The new record replaces the old data       **
4730     '***********************************************
4740     '
4750     LNENO%=VAL(A$)                                     'Get record number
4760     IF LNENO%<1 OR LNENO%>NOREC% GOTO 5570             'Test for valid Rec #
4770     BOT%=LNENO%:     TOP%=LNENO%:      GOSUB 5940      'Set rec # & display
4780     CTFLG%=FALSE%                                      'Reset Counter flag
4790     C%=LNENO%                                          'Set Counter
4800     GOSUB 2260                                         'Go Replace record
4810     RETURN
4820     '
5000 'DELETE ITEM
5010     '***********************************************
5020     '** Records are moved down to overlay the item**
5030     '** being deleted.  The Max record counter is **
5040     '** decremented.                               **
5050     '***********************************************
5060     IF LNENO%<1 OR LNENO%>NOREC% GOTO 5570             'Test for valid Rec #
5070     LNENO%=VAL(A$)                                     'Get record number
5080     BOT%=LNENO%:     TOP%=LNENO%:      GOSUB 5940      'Set rec # & display
5090     INPUT "SURE (Y or N): ",A$                         'Second chance
5100     IF FNL$(Q$)<>"Y" THEN RETURN
5110     FOR K%=LNENO% TO NOREC%                            'Move all records down
5120             LNE$(K%)=LNE$(K%+1)                        'Line number
5130             COL$(K%)=COL$(K%+1)                        'Column Position
5140             LN$(K%)=LN$(K%+1)                          'Field length
5150             FLDNA$(K%)=FLDNA$(K%+1)                    'Field name
5160     NEXT:    NOREC%=NOREC%-1:         RETURN           'Decrement Max rec ctr
5170     '
5400 'LIST ITEMS IN UPDATE MODE
5410     '***********************************************
5420     '** Lists All items, Single item or a range of**
5430     '** Items depending on the parameters entered **
5440     '***********************************************
5450     '
5460     PRINT:   DPB$="D"
5470     IF A$="" THEN BOT%=1:TOP%=NOREC%:         GOTO 5540
5480     J%=INSTR(A$,"-")                                   'Test for '-'
5490     IF J%=0 THEN LNENO%=VAL(A$):      GOTO 5560
5500     BOT%=VAL(LEFT$(A$,J%-1))                           'Set Low rec number
5510     IF BOT%<1 THEN BOT%=1
5520     TOP%=VAL(MID$(A$,J%+1))
5530     IF TOP%>NOREC% THEN TOP%=NOREC%                    'Set Hi rec number
5540     IF BOT%<TOP% THEN GOSUB 5940:     RETURN           'Go list
5550     GOTO 5570                                          'Invalid rec numbers
5560     IF LNENO%>0 AND LNENO%<=NOREC% GOTO 5580           'Test Rec number
5570     PRINT "Line No. out of Range":   RETURN            'Display error message
5580     BOT%=LNENO%:     TOP%=LNENO%                       'Set list range
5590     GOSUB 5940:      RETURN                            'Go list
5600     '
5800 'LISTS or PRINTS RECORDS IN COMMAND MODE
5810     '***********************************************
5820     '** Lists or Prints the complete Control Table**
5830     '** This routine is also used by the Update    **
5840     '** Mode.                                      **
5850     '***********************************************
```

Listing 2 continued:

```
5860
5870    PRINT:  BOT%=1: TOP%=NOREC%:SCNT%=0:LCNT%=0          ´Set list range for all
5880    INPUT "Display, Print or Both (D, P OR B): ",A$
5890    DPB$=A$:        IF A$="<" THEN RETURN
5900    IF A$="D" THEN PRINT CHD1$:       PRINT CHD2$:      GOTO 5940
5910    IF A$<>"P" AND A$<>"B" GOTO 5880
5920    INPUT "Position Paper: c/r ",A$
5930    GOSUB 6090                                           ´Heading
5940    FOR I%=BOT% TO TOP%
5950            A$=RIGHT$("    "+STR$(I%),4)+".  "           ´Record number
5960            IF DPB$="P" GOTO 5990
5970            PRINT A$;LNE$(I%);TAB(13-LEN(COL$(I%)));COL$(I%);
5980            PRINT TAB(18-LEN(LN$(I%)));LN$(I%);TAB(22);FLDNA$(I%)
5990            IF DPB$="D" GOTO 6050
6000            LPRINT A$;LNE$(I%);TAB(13-LEN(COL$(I%)));COL$(I%);
6010            LPRINT TAB(18-LEN(LN$(I%)));LN$(I%);TAB(22);FLDNA$(I%)
6020            LCNT%=LCNT%+1:  IF LCNT%<=62 GOTO 6050 ´Test for end of page
6030                    FOR K%=LCNT% TO 66:      LPRINT  ´End of page spacing
6040                    NEXT:    LCNT%=0:        GOSUB 6090´Page heading
6050            IF DPB$="P" GOTO 6070
6060            SCNT%=SCNT%+1:  IF SCNT%=18 THEN SCNT%=0:         INPUT "c/r ",A$
6070    NEXT:   RETURN
6080    ´
6090 ´HEADING
6100    LPRINT: LPRINT
6110    LPRINT "Control Table {";FIL$;"}":LPRINT
6120    LPRINT CHD1$:    LPRINT CHD2$:    LPRINT             ´Column Headings
6130    LCNT%=7:         RETURN                              ´Set line counter
6140    ´
7000 ´WRITE CONTROL TABLE FILE
7010    ´**********************************************
7020    ´** This routine writes the Control Table data**
7030    ´** to a sequential file.                     **
7040    ´**********************************************
7050    ´
7060    IF A$="<" GOTO 1060
7070    INPUT "Write File (Y or N): ",A$
7080    IF A$="Y" GOTO 7100
7090    IF A$<>"N" GOTO 7070 ELSE GOTO 8060
7100    INPUT "Write to Drive (A or B): ",DRV$
7110    IF DRV$="<" GOTO 7070
7120    IF FIL$="" GOTO 7170
7130    IF DRV$<>"A" AND DRV$<>"B" GOTO 7100
7140    INPUT "Same File Name (Y or N): ",A$
7150    IF A$="<" GOTO 7100
7160    IF A$="Y" GOTO 7190
7170    INPUT "Enter Table Name: ",FIL$
7180    IF FIL$="<" GOTO 7100
7190    OPEN "O",1,DRV$+":"+FIL$+".TBL"                      ´Open output file
7200    PRINT "Writing {";NOREC%;"} Records"
7210    FOR I%=1 TO NOREC%
7220            PRINT #1,LNE$(I%);",";COL$(I%);",";          ´Line No & Col Posn
7230            PRINT #1,LN$(I%);",";                        ´Length
7240            WRITE #1,FLDNA$(I%)                          ´Field name
7250    NEXT
7260    CLOSE #1                                             ´Close file
7270    ´
8000 ´AGAIN
8010    ´**********************************************
8020    ´** This routine allows the user to Build or  **
8030    ´** Update another Control Table without      **
8040    ´** leaving the program.                      **
8050    ´**********************************************
8060    ´
8070    INPUT "Again (Y or N): ",A$
8080    IF A$="N" THEN END
8090    IF A$<>"Y" GOTO 8070
8100    INPUT "Same Control Table (Y or N): ",A$
8110    IF A$="<" GOTO 8070
8120    IF A$="N" THEN NOREC%=0:UDT%=FALSE%:GOTO 1060        ´Reset Max ctr & flag
8130    IF A$<>"Y" GOTO 8100 ELSE GOTO 1060
```

Listing 3: *A sample control table developed using the purchase order form shown in figure 1.*

Control Table {PO}

Item No	Ln No	Col No	Fld Len	Field Name
1.	4	10	30	Company Name
2.	4	44	8	´Contact:
3.	4	57	25	Contact name
4.	5	10	30	Company Address
5.	5	57	14	Contact Phone
6.	6	10	30	City, State, Zip
7.	9	10	30	PO to Company
8.	9	58	25	Ship to Name
9.	11	10	30	PO to Address 1
10.	11	58	25	Ship to Address
11.	12	10	30	PO to Address 2
12.	13	10	30	PO to City, State, Zip
13.	13	58	25	Ship to City, State, Zip
14.	17	2	12	For
15.	17	20	14	Req.No.
16.	17	37	12	How Ship
17.	17	51	8	Date Required
18.	17	60	8	Terms
19.	17	70	11	Date
20.	20	5	5	Ordered 1
21.	20	12	5	Received 1
22.	20	20	42	Item Desc 1
23.	20	64	7	Price 1
24.	20	74	7	Unit 1
25.	22	5	5	Ordered 2
26.	22	12	5	Received 2
27.	22	20	42	Item Desc 2
28.	22	64	7	Price 2
29.	22	74	7	Unit 2
30.	24	5	5	Ordered 3
31.	24	12	5	Received 3
32.	24	20	42	Item Desc 3
33.	24	64	7	Price 3
34.	24	74	7	Unit 3
35.	26	5	5	Ordered 4
36.	26	12	5	Received 4
37.	26	20	42	Item Desc 4
38.	26	64	7	Price 4
39.	26	74	7	Unit 4
40.	28	5	5	Ordered 5
41.	28	12	5	Received 5
42.	28	20	42	Item Desc 5
43.	28	64	7	Price 5
44.	28	74	7	Unit 5
45.	30	5	5	Ordered 6
46.	30	12	5	Received 6
47.	30	20	42	Item Desc 6
48.	30	64	7	Price 6
49.	30	74	7	Unit 6
50.	32	5	5	Ordered 7
51.	32	12	5	Received 7
52.	32	20	42	Item Desc 7
53.	32	64	7	Price 7
54.	32	74	7	Unit 7

Text continued from page 222:

the program issues only a carriage return and waits for a response. If your printer includes a line feed, you will have to crank the form back one line before repositioning. When the form is aligned satisfactorily, the program prints the grid on the form. Figure 2 shows a sample standard purchase-order form that has been gridded with the FFGRID-1 program.

Building a Forms-Control Table

Using the gridded form, you can determine the line and column positions to be used in building a control table (see listing 2). At the same time, the maximum length for each field can be specified.

Listing 3 shows the control table created with the FFTABL-1 program for the purchase-order form. This control-table file will also be used by the FFORM-1 program to display the field names for data entry, determine the maximum field length, and provide the line and column position for each data field.

FFTABL-1, like the other programs, scrolls up from the bottom of the screen, so no cursor positioning is required.

When the FFTABL-1 program comes up in the command mode, you are given the choice of building a new control table, updating or changing an existing control table, listing an existing control table to the screen or printer, or ending the program and writing out the control table to disk. The program always returns to the command mode after each mode is finished.

Build Mode: When the Build mode is entered, a column heading is dis-

played with item number 1 on the next line. After each entry is made, the item number is incremented by one. An entry consists of the line number, the column position, the maximum field length, and a field name (see figure 3). The field name is displayed by the FFORM-1 program for data entry. Commas are required as delimiters between fields.

While in the Build mode you may reenter the previous field by entering a < or go back to any previously entered item by entering <N, where N is the item number. The program issues an error message if N is less than 1 or greater than the largest item number. The Build Mode is terminated by entering the word END.

List Mode: After the Build mode is ended, you may list the control table on the screen or print the table. The program lists 18 lines on the screen and then requests a carriage return before listing the next 18 lines. If printed, the program takes care of column headings for a 66-line page. A previously prepared control table can also be read and listed.

Update Mode: In the Update mode you can:

- Insert: Enter the code IN, with N being the item number of the record to be inserted. If I9 is used, item 9 will be renumbered to 10, 10 will be moved to 11, etc. The inserted record becomes item 9. All previous records are moved up to make room for the insertion. Item numbers greater than N will be incremented. To append records to the end of the file use I to insert an item number greater than the highest item number in the file or return to the Command mode and use the Build mode.
- Replace: The entry of RN will allow a new entry for item N. This entry replaces the existing record with the new record.
- Delete: DN causes item N to be deleted. All records will be moved down. Item numbers greater than the N used will be decremented.
- List: The list commands allow you to L all items, L# a single item, or L#-# a range of items (# is the number of an item).
- End: END terminates the Update mode and returns the program to the Command mode.

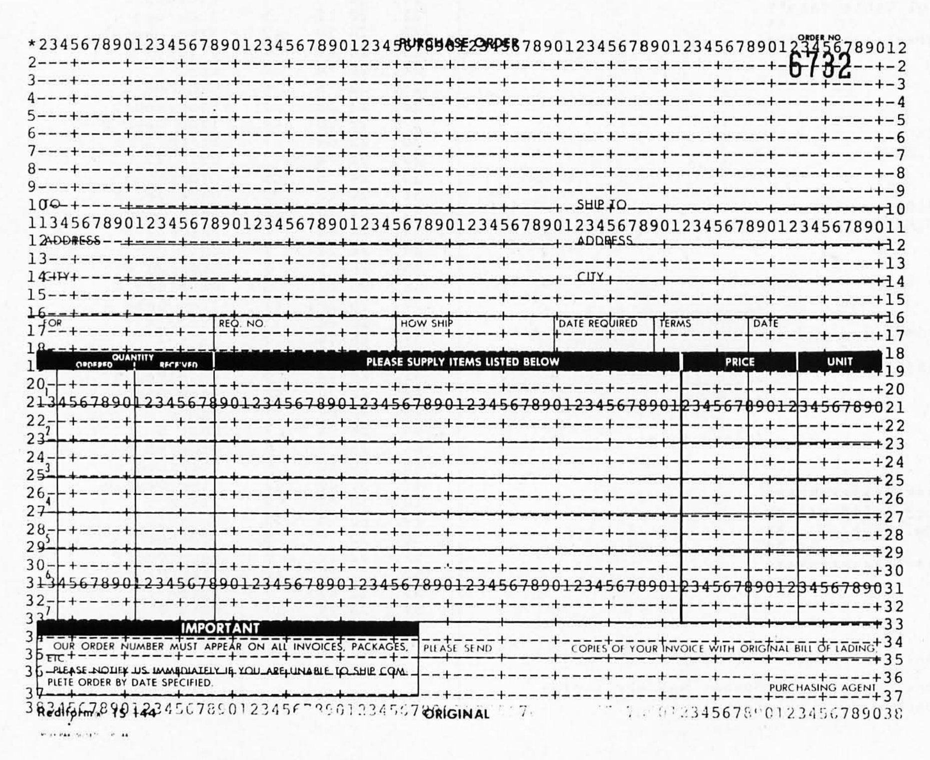


Figure 2: *The FFGRID-1 program prints a grid over your form that allows you to determine the coordinates for the various data fields.*

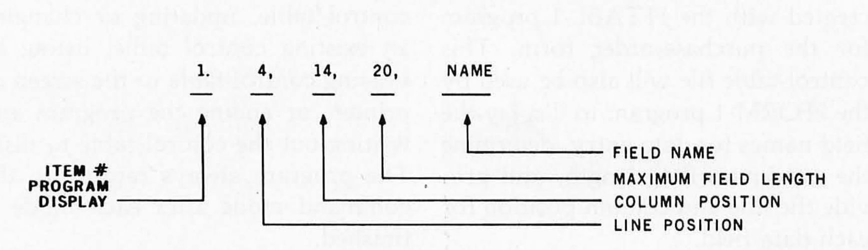


Figure 3: *In the Build mode, the FFTABL-1 program prompts you to enter the data for each field.*

Valid Entries

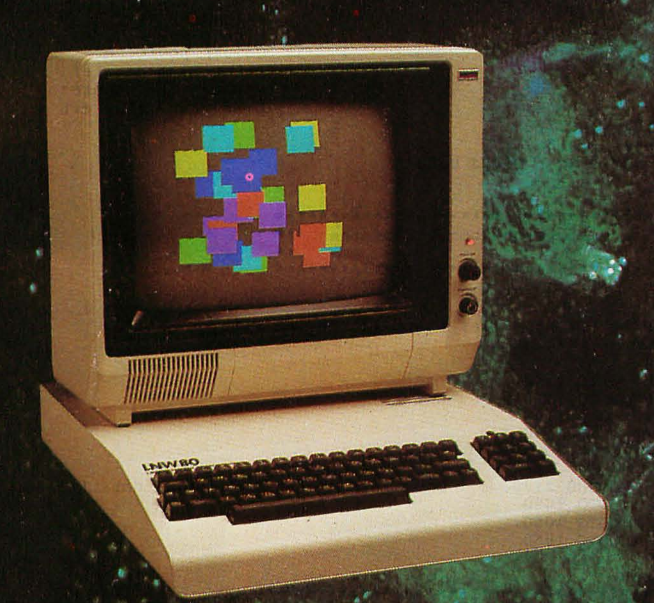
The fields that make up a record are entered as a string, then broken up into individual fields. This allows use of < and END, which would never work in BASIC if the line-number field was a numeric field. The program edits each record to make sure it is valid by

- Checking for commas as delimiters between fields
- Checking for line or column positions less than 1
- Checking to make sure that line numbers increment (for example, you cannot insert line number 20 ahead of line number 15)
- Checking to make sure that fields on a line do not overlap (a field starting in column position 20 that is 20 characters long cannot be followed by a field starting in column 30)
- Issuing error messages when the record is not valid and displaying the same item number again for a correct entry

Once a control table is built, it can be changed by running the control-

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table file through the FFTBAL-1 program. Use the Update mode to insert, delete, or replace the line and column positions that need adjusting so that the data fields will fit properly on the form.

Filling in a Form

After building a control table, the FFORM-1 program is used to enter the data to be printed on the form (see listing 4). When the program is loaded it goes into the Command mode and gives you the following options:

- Build: Build new data arrays; these may be printed or written to disk.
- Change: Change the data in the data array or data file (fix errors).
- List: List the data-array file, showing the line and column position and data for each field. The listing may be displayed or sent to the printer. You can specify that the whole file, a single field, or a range of fields be listed.
- Print: Print out the form on the printer or display the data on the screen as it would look on the form.

While in the Command mode, the FFORM-1 program functions the same as the other two programs. User options include:

Build: The control table that provides the line and column positions and field names is first read into an array. The program then displays the first field number and field name, together with underscores corresponding to the maximum field length. You enter the data for that field and hit the carriage return. The program will display the field number and field name for the second field. For blank fields, a carriage return is entered. The use of the < and <N for reentering data is the same as in the FFTBL-1 program. If you want to stop before reaching the end of the table, enter <END to go back to the Command mode.

Form designers have been known to ignore the fact that typewriters and printers are generally unable to han-

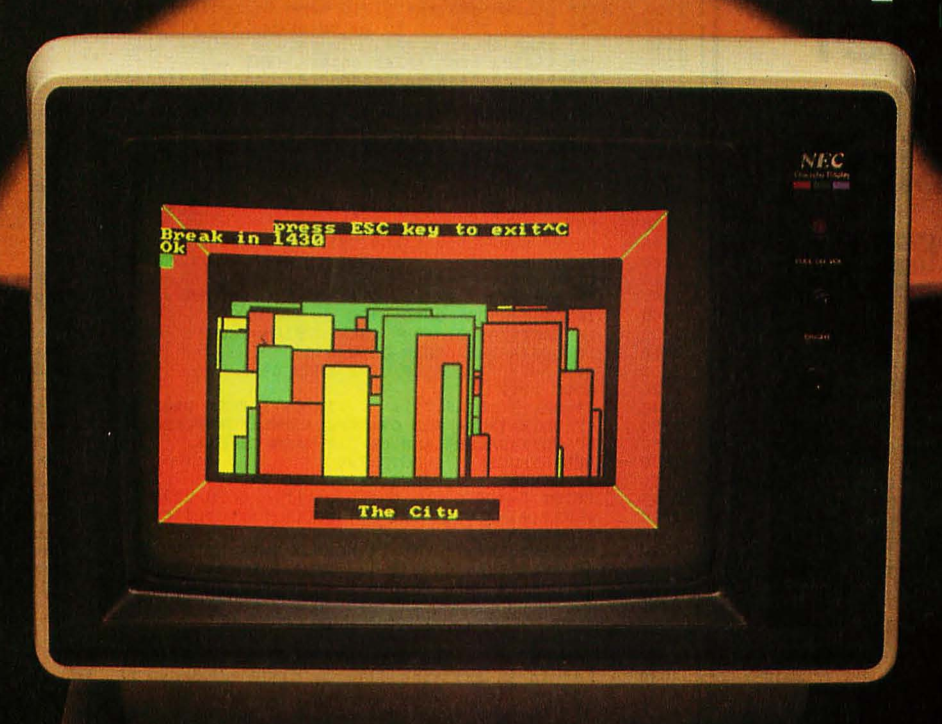
Text continued on page 236

Listing 4: *The FFORM-1 program prints out the form or allows you to enter or change data in the data file.*

```
10      '*****************************************
20      '**                                     **
30      PRINT:  PRINT                          '**
40      PRINT "           FFORM-1.BAS"         '**
50      PRINT "FillForm File and Print Program"   '**
60      PRINT "Copyright 1981 by Elliam Assocates"'**
70      '**                                     **
80      '**     This Program Builds a Form File   **
90      '**     and/or Fills Out a Form - uses    **
100     '**     a control table built with        **
110     '**     FFTBL-1                           **
120     '**                                     **
130     '*****************************************
140     '
150     'Program set for 100 fields
160     '
500 'INITIALIZATION
510     '*********************************************
520     '** Dimension arrays, Set flags and Initialize**
530     '** variables                                **
540     '*********************************************
550     '
560     DIM LCL$(3),LNE$(100),COL$(100),LN$(100),FLDNA$(100)
570     DIM FLNE$(100),FCOL$(100),FDTA$(100)
580     FALSE%=0:       TRUE%=-1
590     NOREC%=0                                        'Max No of Ctl Tbl Records
600     NODTA%=0                                        'Max No of Data Records
610     CTFLG%=FALSE%                                   'Record counter flag
620     RFL%  =FALSE%                                   'Re-enter flag
630     UDT%  =FALSE%                                   'Control tbl read flag
640     FUDT% =FALSE%                                   'Data file read flag
650     EDFLG%=FALSE%                                   'Edit flag
660     CNTR% =0                                        'Record ctr in print routine
670     OK%   =0                                        'Alignment flag
680     C1%   =0                                        'Line number
690     C2%   =0                                        'Column position
700     LNO%  =0                                        'Print line counter
710     SCNT% =0                                        'Screen line counter
720     LCNT% =0                                        'List print line ctr
730     DEF FNL$(Q$)=LEFT$(A$,1)
740     CHD1$=" Item Lne   Col"
750     CHD2$="   No  No    No   Field Data"
760     '
1000 'COMMAND MODE
1010    '*********************************************
1020    '** This section directs the control of the   **
1030    '** program                                   **
1040    '*********************************************
1050    '
1060    PRINT
1070    PRINT "Build File, Change File, List File, Print File or END ";
1080    INPUT "(B,C,L,P or E):",A$
1090    CMD$=A$
1100    IF FNL$(Q$)="B" GOTO 1160
1110    IF FNL$(Q$)="C" GOTO 1170
1120    IF FNL$(Q$)="L" GOTO 1180
1130    IF FNL$(Q$)="P" GOTO 1190
1140    IF FNL$(Q$)="E" GOTO 7050
1150    GOTO 1060
1160    FUDT%=FALSE%:   GOSUB 2170:     GOTO 1060       'Reset Read data flag
1170    GOSUB 4100:     GOTO 1050
1180    GOSUB 4570:     GOTO 1050
1190    GOSUB 8490:     GOTO 1050
1200    '
1500 'READ CONTROL TABLE
1510    '*********************************************
1520    '** This routine reads the sequential control **
1530    '** table file and places each field in the   **
1540    '** appropriate array for use in building a   **
1550    '** data file.                                **
1560    '*********************************************
1570    '
1580    IF UDT% THEN RETURN                             'If file has been read ret
1590    INPUT "Control Table Drive (A or B): ",A$       'Get drive for file
1600    DRV$=A$:        IF DRV$="<" THEN RETURN
1610    IF DRV$<>"A" AND DRV$<>"B" GOTO 1590            'NOTE: <filename>
1620    INPUT "Enter Table Name: ",FIL$                 '  extension set to 'TBL'
1630    IF FIL$="<" GOTO 1590
1640    OPEN "I",1,DRV$+":"+FIL$+".TBL"                 'Open file
1650    PRINT:  PRINT "Reading {";FIL$;"} Table"        'Display message
1660    FOR I%=1 TO 1000                                'Read Table file
1670            IF EOF(1) GOTO 1720
1680            INPUT #1,LNE$(I%),COL$(I%),LN$(I%)
1690            LINE INPUT #1,A$
1700            A$=MID$(A$,2):  FLDNA$(I%)=LEFT$(A$,LEN(A$)-1)  'Strip quotes
1710    NEXT                                                      'from string
1720    NOREC%=I%-1                                     'Number of table recs
1730    PRINT:  PRINT NOREC% "Table Entries Read"
1740    PRINT:  UDT%=TRUE%                              'Set update flag
1750    CLOSE #1                                        'Close file
1760    RETURN
1770    '
2000 'BUILD DATA FILE
2010    '*********************************************
2020    '** This routine builds a data file.  It is   **
2030    '** also used to change a data field.  The    **
2040    '** user may go back and re-enter a previous  **
2050    '** field by entering '<' or to any field     **
```

Listing 4 continued on page 234

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Listing 4 continued:

```
2060      '** number by entering '<N' where 'N' is the  **
2070      '** field number.  Each field name is display-**
2080      '** ed followed by a number of underscores.   **
2090      '** The number of underscores corresponds to  **
2100      '** maximum length of the field.  If the      **
2110      '** entry is to long an error message is dis- **
2120      '** played and the field name is redisplayed. **
2130      '** If no data is to be entered in a field    **
2140      '** then enter a c/r.  To escape before all   **
2150      '** fields are filled enter '<END'.           **
2160      '**********************************************
2170      '
2180      GOSUB 1570                                         'Read control tbl file
2190      PRINT "<< BUILD MODE >>":         PRINT
2200      IF FUDT% THEN C%=NODTA%:          GOTO 2220        'If data file in  memory
2210      C%=0
2220      C%=C%+1:          C1%=C%                           'Increment counter & save
2230      RFL%=FALSE%:      CTFLG%=FALSE%                    'Reset flags
2240      PRINT TAB(LEN(FLDNA$(C%))+9);                      'Tab & Display underscores
2250      PRINT STRING$(VAL(LN$(C%)),"_");CHR$(13);          '  then c/r to left
2260      PRINT RIGHT$("    "+STR$(C%),4)+". ";FLDNA$(C%);": ";    'field name
2270      LINE INPUT "",A$                                   'enter data
2280      IF A$="<END" THEN NODTA%=C%-1:  RETURN             'Check for escape
2290      IF A$="<STOP" GOTO 2400
2300      IF LEFT$(A$,1)<>"<" THEN CTFLG%=TRUE%:  GOTO 2380        'Ck for re-enter
2310      IF LEN(A$)<>1 THEN GOTO 2340                       'Test for record no.
2320      C%=C%-1:          IF C%<1 THEN C%=1                'Decrement field ctr
2330      GOTO 2240
2340      C%=VAL(MID$(A$,2)):        IF C%<1 THEN C%=1       'Get field number
2350      IF UDT%=TRUE% AND C%>NOREC% THEN C%=NOREC%         'Range test field no.
2360      IF UDT%=FALSE% AND C%>C1% THEN C%=C1%              '  "     "     "    "
2370      RFL%=TRUE%:       GOTO 2240                        'Set re-enter flag
2380      IF LEN(A$)<=VAL(LN$(C%)) GOTO 2400                 'Test length
2390      PRINT "<<<T o o   L o n g>>>":  GOTO 2240          'Error message
2400      FLNE$(C%)=LNE$(C%):        FCOL$(C%)=COL$(C%)      'Store line & col posn
2410      FDTA$(C%)=A$                                       'Store data
2420      FUDT%=TRUE%:      IF C%=NOREC% THEN RETURN         'Set no read data flag
2430      IF RFL% THEN C%=C1%-1:  RFL%=FALSE%                'Reset counter & flag
2440      IF EDFLG% THEN RETURN ELSE GOTO 2220
2450      '
4000  'CHANGE
4010      '**********************************************
4020      '** This routine allows a user to change the  **
4030      '** in an existing file by field number.  If  **
4040      '** no field number is supplied from the      **
4050      '** Command mode the program requests a field **
4060      '** number.  The old data is displayed so the **
4070      '** user can see what was in the field.  Also **
4080      '** the line and column position are displayed**
4090      '**********************************************
4100      '
4110      GOSUB 9050:       IF A$="<" THEN RETURN            'Read Data file
4120      GOSUB 1570:       IF A$="<" THEN RETURN            'Read Ctl tbl
4130      EDFLG%=FALSE%                                      'Reset edit flag
4140      A$=MID$(CMD$,2)                                    'Get field no.
4150      IF VAL(A$)<1 OR VAL(A$)>NOREC% THEN INPUT "Record #: ",A$
4160      IF A$="<" THEN RETURN                              'No change - return
4170      IF VAL(A$)>0 AND VAL(A$)<=NOREC% GOTO 4190         'Range test field no.
4180      PRINT "Line No. out of Range":  GOTO 4150          'Display error msg.
4190      EDFLG%=TRUE%                                       'Set edit flag
4200      C%=VAL(A$):       DPB$="D"                         'Set Rec# & Dsplay
4210      BOT%=C%:          TOP%=C%                          'Set Rec #
4220      GOSUB 4850:       GOSUB 2240:     RETURN           'List/Enter Chg
4230      '
4500  'LIST CONTROL
4510      '**********************************************
4520      '** This section sets up the parameters for a **
4530      '** listing.  All fields, single field or a   **
4540      '** range of fields depending on the          **
4550      '** entered.                                  **
4560      '**********************************************
4570      '
4580      GOSUB 9050:       IF A$="<" THEN RETURN            'Read Data file
4590      DPB$="D":         A$=MID$(CMD$,2)
4600      IF A$="" THEN BOT%=1:TOP%=NODTA%:         GOTO 4640        'No prams - All
4610      J%=INSTR(A$,"-"):IF J%=0 THEN LNENO%=VAL(A$):  GOTO 4660
4620      BOT%=VAL(LEFT$(A$,J%-1)):        IF BOT%<1 THEN BOT%=1  'Test range
4630      TOP%=VAL(MID$(A$,J%+1)):         IF TOP%>NODTA% THEN TOP%=NODTA%
4640      IF BOT%<TOP% THEN GOSUB 4770:   RETURN             'Go list
4650      GOTO 4670
4660      IF LNENO%>0 AND LNENO%<=NODTA% GOTO 4680           'Test range of fields
4670      PRINT:  PRINT "Line No. out of Range":  RETURN     'Error message
4680      BOT%=LNENO%:      TOP%=LNENO%:    GOSUB 4770:      RETURN
4690      '
4700  'LIST DATA FILE
4710      '**********************************************
4720      '** Displays or prints the selected part of   **
4730      '** the data file.  Field numbers, line nos,  **
4740      '** column numbers and data are output.  A    **
4750      '** Column heading is available when printing.**
4760      '**********************************************
4770      '
4780      PRINT
4790      INPUT "Display, Print or Both (D, P OR B): ",A$
4800      PRINT:  DPB$=A$:          IF A$="<" THEN RETURN
4810      IF A$="D" THEN PRINT CHD1$:      PRINT CHD2$:      GOTO 4850
4820      IF A$<>"P" AND A$<>"B" GOTO 4790
4830      INPUT "Position Paper: c/r ",A$
4840      GOSUB 8910                                         'Heading
4850      SCNT%=0
4860      FOR I%=BOT% TO TOP%
4870             A$=RIGHT$("    "+STR$(I%),4)+".  "          'Field number
```

Listing 4 continued:

```
4880          IF DPB$="P" GOTO 4940
4890          PRINT A$;FLNE$(I%);TAB(16-LEN(FCOL$(I%)));
4900          PRINT FCOL$(I%);TAB(20);FDTA$(I%)
4910          IF DPB$<>"D" GOTO 4950
4920          SCNT%=SCNT%+1:  IF SCNT%<18 GOTO 5000   'Screen line count
4930          INPUT "c/r ",A$:        SCNT%=0:        GOTO 5000
4940          IF DPB$="D" GOTO 5000
4950          LPRINT A$;FLNE$(I%);TAB(16-LEN(FCOL$(I%)));
4960          LPRINT FCOL$(I%);TAB(20);FDTA$(I%)
4970          LCNT%=LCNT%+1:  IF LCNT%<62 GOTO 5000   'Test for end of page
4980                  FOR K%=LCNT% TO 66:     LPRINT  'End of page spacing
4990                  NEXT:   LCNT%=0:        GOSUB 8910      'Heading
5000    NEXT:   RETURN
5010    '
7000 'WRITE DATA FILE
7010    '**********************************************
7020    '** This routine writes the data in the arrays**
7030    '** to a sequential file.                    **
7040    '**********************************************
7050    '
7060    GOSUB 1560                                    'Get control table
7070    INPUT "Write File (Y or N): ",A$
7080    IF A$="Y" GOTO 7100
7090    IF A$<>"N" GOTO 7070 ELSE GOTO 8080
7100    INPUT "Write to Drive (A or B): ",A$
7110    DRV$=A$:        IF A$="<" GOTO 7070
7120    IF DRV$<>"A" AND DRV$<>"B" GOTO 7100
7130    INPUT "Enter File Name: ",FIL$
7140    IF FIL$="<" GOTO 7100
7150    IF FIL$="" THEN FIL$=FFIL$
7160    OPEN "O",1,DRV$+":"+FIL$+".FLE"
7170    PRINT "Writing {";NODTA%;"} Records"
7180    FOR I%=1 TO NODTA%
7190          PRINT #1,LNE$(I%);",";COL$(I%);",";     'Line & col Posn
7200          WRITE #1,FDTA$(I%)                      'Data field
7210    NEXT
7220    '
7230    CLOSE #1
7240    '
8000 'AGAIN
8010    '**********************************************
8020    '** This section allows the user to:          **
8030    '**   1. Build another data file.             **
8040    '**   2. Print another data file.             **
8050    '**   3. Change another  data file.           **
8060    '** without leaving the program.              **
8070    '**********************************************
8080    '
8090    INPUT "Again (Y or N): ",A$
8100    IF A$="N" THEN END
8110    IF A$<>"Y" GOTO 8090
8120    INPUT "Same Control Table (Y or N): ",A$
8130    IF A$="<" GOTO 8090
8140    IF A$="N" GOTO 1060
8150    IF A$<>"Y" GOTO 8120
8160    INPUT "Same Data File (Y or N): ",A$
8170    IF A$="<" GOTO 8120
8180    IF A$="N" THEN FUDT%=FALSE%:    GOTO 1060
8190    IF A$<>"Y" GOTO 8160 ELSE GOTO 1070
8200    '
8400 'PRINT CONTROL
8410    '**********************************************
8420    '** This routine uses a line counter LNO%,    **
8430    '** when the line number C1% in the record    **
8440    '** matches LNO% the data is printed at TAB   **
8450    '** position C2%.  After the first data field **
8460    '** is printed the program allows the user to **
8470    '** realign the form if necessary.            **
8480    '**********************************************
8490    '
8500    GOSUB 9050:     IF A$="<" THEN RETURN         'Read data file
8510    PRINT
8520    INPUT "Display, Print or Both (D, P OR B): ",A$
8530    FDPB$=A$:       IF A$="<" THEN RETURN
8540    IF FDPB$<>"D" THEN LPRINT                     'Clear Printer Buffer
8550    IF FDPB$<>"D" THEN INPUT "Position Form: ",A$
8560    'C1%=LINE, C2%=SPOSN, CNTR%=PRINT LINR COUNTER
8570    CNTR%=0:        :OK%=0: LNO%=0                'Clear counters & flag
8580    C1%=VAL(FLNE$(CNTR%)):  C2%=VAL(FCOL$(CNTR%)) 'Line #/Col posn
8590    IF LEN(FDTA$(CNTR%))=0 GOTO 8750              'No data for field ?
8600    IF C1%-LNO%=1 GOTO 8640                       'Check for matching lines
8610    LNO%=LNO%+1                                   'Increment line counter
8620    IF FDPB$="D" OR FDPB$="B" THEN PRINT:   GOTO 8600   'Blank line
8630    IF FDPB$="P" OR FDPB$="B" THEN LPRINT:  GOTO 8600   'Blank line
8640    GOSUB 8840                                    'Print Field
8650    ON OK% GOTO 8750                              'Continue or align
8660    PRINT
8670    IF FDPB$="D" THEN A$="Y":       GOTO 8730
8680    INPUT "Alignment OK, Ck Next Field or Quit (Y, C or Q): ",A$
8690    IF A$<>"Q" GOTO 8730
8700    IF FDPB$<>"P" THEN PRINT
8710    IF FDPB$<>"D" THEN LPRINT
8720    RETURN
8730    IF A$<>"Y" AND A$<>"C" GOTO 8670              'Test valid entry
8740    OK%=0:  IF A$="Y" THEN OK%=1                  'Set continue flag
8750    CNTR%=CNTR%+1:  IF CNTR%<=NODTA% GOTO 8580    'Inc Ctr & Test EOF
8760    PRINT:  IF FDPB$<>"D" THEN LPRINT:      RETURN
8770    '
8780 'PRINT FIELD
8790    '**********************************************
```

Listing 4 continued on page 236

Listing 4 continued:

```
8800     '** Check for <STOP to allow for repositioning**
8810     '** the form.  Print data field at line number**
8820     '** and column Position.                       **
8830     '***********************************************
8840     '
8850     IF FDTA$(CNTR%)<>"<STOP" GOTO 8870            'Test for reposn
8860     INPUT "Reposition Form c/r ",Z$:        RETURN
8870     IF FDPB$<>"P" THEN PRINT TAB(C2%);FDTA$(CNTR%); 'Display field
8880     IF FDPB$<>"D" THEN LPRINT TAB(C2%);FDTA$(CNTR%);'Print field
8890     RETURN
8900     '
8910 'HEADING
8920     LPRINT: LPRINT
8930     LPRINT "Data File {";FFIL$;"}": LPRINT
8940     LPRINT CHD1$:    LPRINT CHD2$:    LPRINT        'Print column heading
8950     LCNT%=7:         RETURN                        'Set line counter
8960     '
9000 'READ DATA FILE
9010     '***********************************************
9020     '** This routine reads a data file and places **
9030     '** the data in appropriate arrays.           **
9040     '***********************************************
9050     '
9060     IF FUDT% THEN RETURN
9070     INPUT "Form File Drive (A or B): ",A$:  DRV$=A$
9080     IF DRV$="<" THEN RETURN
9090     IF DRV$<>"A" AND DRV$<>"B" GOTO 9070
9100     INPUT "Enter Form File Name: ",FFIL$
9110     IF FFIL$="<" GOTO 9070
9120     OPEN "I",1,DRV$+":"+FFIL$+".FLE"
9130     PRINT:  PRINT "Reading {";FFIL$;"} Form File"
9140     FOR I%=1 TO 1000
9150             IF EOF(1) GOTO 9200
9160             INPUT #1,FLNE$(I%),FCOL$(I%)
9170             LINE INPUT #1,A$
9180             A$=MID$(A$,2):  FDTA$(I%)=LEFT$(A$,LEN(A$)-1)    'Strip quotes
9190     NEXT                                                     'from string
9200     NODTA%=I%-1
9210     PRINT:  PRINT NODTA% "Form File Entries Read":  PRINT
9220     FUDT%=TRUE%
9230     CLOSE #1
9240     RETURN
```

Text continued from page 232:
dle forms with unusual line spacing. If the form has unusual line spacing, the print program can be stopped so the form can be realigned: just enter <STOP for the field name and the program will stop on the selected line at the selected column. Reposition Form will be displayed on the screen.

Once back in the Command mode the data can be changed, listed, written to disk, displayed on the screen, or sent to the printer.

Change: If the change command is used when the program starts up, you will be requested to enter the file name for a previously saved data file and control table. If you enter C while using the FFORM-1 program, it will request the field number to change. If you enter CN, the program will display the current data for field N. You can then change the data for that field and the program will be ready for the next command.

List: The list command, like the change command, can be used with a

Introducing The FinalWord!

Word processing that goes beyond the stars.

How could anyone call their word processor The FinalWord? Take the best features of the most popular word processors, combine them and add a few more in one text editor/formatter and you'd be off to a good start. Then, write the program in C to allow user customization and make it capable of supporting any printer on the market and you'd be ahead of everybody else. If you went one step further and made your word processor transportable from one terminal to another you'd have—The FinalWord.

The FinalWord
Mark of the Unicorn

Supports multiple printers: The FinalWord allows you to produce high-speed draft copies on one printer, and letter-quality on another. It also means you'll never need another version just because you bought a new printer.

User-installable on different hardware: With The FinalWord you can upgrade your system and still have a familiar screen display. And since we've written The FinalWord in C, new versions are available almost as soon as new computers.

Features that go beyond the stars: Look at what you get with The FinalWord: automatic generation of Table of Contents, Index, footnoting and chapter/section numbering; enhanced command sets (delete/move a letter, word, sentence, paragraph, page); multiple buffers and windows, deletion recovery, true proportional spacing and more. And because we wrote The FinalWord to be easily reconfigured for different systems, our price can be lower.

Features	The FinalWord	WordStar	Magic Wand
Full-Screen Editing	Yes	Yes	Yes
Directory Access while Editing	Yes	Yes	Yes
Simultaneous Printing while Editing	Yes	Yes	Yes
External Commands while Editing	Yes	Yes	No
Video Highlighting	Yes	Yes	No
Automatic Footnotes	Yes	No	No
User-Defined Commands	Yes	No	No
Multiple File Editing	Yes	No	No
Deletion Recovery	Yes	No	No
Supports Multiple Printers	Yes	No	No
Crash Recovery	Yes	No	No
Dynamic Include Files	Yes	No	Yes
Suggested Retail Price	**$300**	**$495**	**$395**

The FinalWord requires a 56K CP/M system and video terminal with cursor positioning character sequences. It is presently available in 8" standard format for the TRS-80 Model II, Vector Graphics and Altos Systems. There are compatible versions for the HP-125, Xerox 820, Cromemco, Micropolis, Ohio Scientific and Dynabyte Systems, and there are 5¼" versions for the Heath/Zenith Z-89, Northstar, Apple and Superbrain. **Coming Soon: The FinalWord for the IBM Personal Computer.**

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Arlington, Massachusetts 02174
(617) 489-1387

Dealer and OEM inquiries invited.
Call for delivery schedule.
Reserve yours now!



Listing 5: *A sample data file developed with the FFORM-1 program. The data is also shown in the completed form in figure 4.*

```
Data File {RIDE}

 Item Lne   Col
  No  No    No    Field Data

  1.  4     10     Easyoff Riding Stables
  2.  4     44     Contact:
  3.  4     57     Fred Horseman
  4.  5     10     123 Pony Lane
  5.  5     57     (555) 123-4567
  6.  6     10     Mustang, AZ 10001
  7.  9     10     Mavrick Supply Company
  8.  9     58     Easyoff Riding Stables
  9.  11    10     456 Whitehorse Blvd.
 10.  11    58     Back Gate
 11.  12    10     Quarterhoss,  AZ  10002
 12.  13    10
 13.  13    58     Mustang,  AZ 10001
 14.  17     2     Stock
 15.  17    20     S78-9
 16.  17    37     Livery Wagon
 17.  17    51     Y'terday
 18.  17    60     net 10
 19.  17    70     Mo/Da/Yr
 20.  20     5       12
 21.  20    12
 22.  20    20     Soft Pillows
 23.  20    64       3.75
 24.  20    74     each
 25.  22     5       1
 26.  22    12
 27.  22    20     Saddle Glue
 28.  22    64       37.50
 29.  22    74     case
 30.  24     5       1
 31.  24    12
 32.  24    20     Saddle sore liniment
 33.  24    64       27.80
 34.  24    74     box
```

PURCHASE ORDER

ORDER NO 6731

Easyoff Riding Stables
123 Pony Lane
Mustang, AZ 10001

Contact: Fred Horseman
(555) 123-4567

TO Mavrick Supply Company — SHIP TO Easyoff Riding Stables
ADDRESS 456 Whitehorse Blvd. — ADDRESS Back Gate
CITY Quaterhoss, AZ 10001 — CITY Mustang, AZ 10001

FOR	REQ. NO.	HOW SHIP	DATE REQUIRED	TERMS	DATE
Stock	S78-9	Livery Wagon	Y'terday	net 10	Mo/Da/Yr

	QUANTITY ORDERED	RECEIVED	PLEASE SUPPLY ITEMS LISTED BELOW	PRICE	UNIT
1	12		Soft Pillows	3.75	each
2	1		Saddle Glue	37.50	case
3	1		Saddle sore liniment	27.80	box
4					
5					
6					
7					

IMPORTANT
OUR ORDER NUMBER MUST APPEAR ON ALL INVOICES, PACKAGES, ETC.
PLEASE NOTIFY US IMMEDIATELY IF YOU ARE UNABLE TO SHIP COMPLETE ORDER BY DATE SPECIFIED.

PLEASE SEND COPIES OF YOUR INVOICE WITH ORIGINAL BILL OF LADING

PURCHASING AGENT

Rediform® 1S 144

ORIGINAL

Figure 4: *The result of the FFORM-1 program. The information on this form is the same as that in the data file in listing 5.*

data file or used to list the fields just completed. All the fields may be listed by entering L; a single field can be listed using LN; a range of fields can be listed using LN-N, where N is the field number (see listing 5 for a sample data file).

The listing of the sample data file created with the FFORM-1 program contains the item number, line position, column position, and data to be printed at that location.

Print: The print command allows you to display either the array data (created by FFORM-1) or field data, formatted as it would look on the form, or the field data can be used to fill in the form on the printer.

When a printout of a form is requested, the program first asks you to position the form, then prints the first field and allows you to reposition the form. It can then print the next field and stop for forms alignment check, print the rest of the form, or quit. If a data field contains <STOP, the program will stop to allow you to reposition the form. Figure 4 shows the completed purchase order that was printed using sample data fields.

Saving the Data: In the Command mode, the program can be ended by entering E. You then have the option of writing the data arrays to a disk file for future use or rerunning the program.

Depending upon your needs, you can add a number of enhancements to these programs that will make them easier to use, for example:

These programs work best when there is constant use of a standard form, such as insurance forms, applications, or government paperwork.

- Multiple page forms with more than 100 data fields
- Command letters in either uppercase or lowercase
- Left- or right-justified data fields
- String or numeric fields
- An alert to any entry-required fields
- Print constants from the control table
- Special editing and range checking of data
- Use of the INP statement instead of INPUT to eliminate the need of the carriage return for completely filled fields
- Making a mask that looks similar to the form to be filled in and placing it over the screen—then filling in the data in the mask fields (this enhancement requires the use of a display that has an addressable cursor)

Most of these enhancements could be implemented by expanding the number of fields in the control table, then adding more code to support them.

Summary

The Fill Forms System is a relatively simple set of programs that can be used in a wide variety of situations. They work particularly well in situations where a standard form is required—for insurance agencies, application forms, or government documents. The more complex the form and the more frequently it is used, the more time you'll save by using this system. ■

Don't gamble with your business!

Invest in an M System

"Okay, which entry-level, single-user microcomputer should I own?"
The BOS M System.
"Which multi-user system should I own?"
The BOS M System.
"If I want a larger system with the ultimate in performance and capacity, what should I own?"
The BOS M System Multiprocessor.
"How much more does it cost to own a single-user set-up and upgrade it, than to start with a larger system?"
Not a penny more.
"Can I have diskette, tape, and large rigid disk storage?"
Yes.

"How about really good accounting software?"
The MBSI* package (GL, AR, AP, PR, OE/INV, Sales Analysis — all in Cobol) is probably the best available on any system...this is one you have to see to believe.
"How about Word Processing?"
WordStar™, and others.**
"Can I run all the other software I've seen?"
Yes, if it's CP/M* compatible, almost certainly!**
"Will I have to change the operating system when I expand?"
No, with BOS/TURBODOS**, just upgrade it.**

"Well, this is important...will service be available when I need it?"
Yes, with a large dealer network, strategically placed maintenance depots, and fast factory repair turn-around.
"Sounds great! But isn't it too good to be true?"
No...and it's not even expensive! So, why take a chance with somebody else?

"Okay, how can I get one?"
Contact your dealer, systems house, or consultant — or call us toll-free!

Dealer and OEM Inquiries Welcome



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2835 East Platte Avenue
Colorado Springs, Colorado 80909
In Colorado Call: (303) 634-1541
Toll Free Number: 1-800-525-3898

APPLICABLE INDUSTRY STANDARDS: S-100 IEEE 696 • RS 232, HDLC, SDLC, Async, Sync • CP/M*,** TURBODOS**** • 8" soft sectored diskettes • ANSI X3/B5/15 Tape Cartridge

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Tele-VIC

Commodore Breaks the $100 Price Barrier for Modems

Max Lebow
2121 Locust St.
Philadelphia, PA 19103

A really good modem takes a telephone number stored in your computer's memory, dials it, selects the appropriate originate/answer frequencies, and starts communicating at 9600 bits per second (bps). Unfortunately, a really good modem can also cost as much as a good used car.

If you are willing to dial your own telephone, set a manual switch to select originate/answer frequencies, and settle for 300 bps, Commodore's new modem may be an inexpensive solution. In fact, for the price of a moderately good 1200-bps modem, Commodore will sell you its modem and a VIC-20 home computer to go with it.

The modem is the VICMODEM. It is contained in a slim plastic case with an edge connector at one end and a modular telephone jack (for the *handset* cord) at the other. The edge connector attaches directly to the VIC-20, which has a special telecommunications slot to accept this modem or Commodore's RS-232 interface (see photo 1). (The VIC-20 is named for the Video Interface Chip, which provides the necessary interface between the computer and a television set. The VIC-20 has built-in connectors for a television (RF) and a video monitor. It also has a typewriter-style keyboard, which is unusual for a computer in this price range.)

The modem is compactly designed on a single circuit board and conforms to the Bell 103 modem frequencies. It uses Motorola modem integrated-circuit chips and has a crystal to ensure frequency stability. Selection of originate or answer frequencies is accomplished manually by setting a small slide switch on the side of the unit. A carrier-detection LED (light-emitting diode) is also provided.

A cassette contains the object code for the interface program VICTERM I. The features included in this software are impressive. They include:

Word wrap: If the word at the end of a line is too long to fit on that line, it



Photo 1: *This low-cost modem for Commodore's VIC-20 home computer takes a modular plug from a telephone handset and plugs directly into VIC-20's telecomputing slot. The modem shown here is a prototype with a provisional model number.*

Announcing A Media Event From IMS

Configuration shown includes two slimline double sided, double density drives, 40 M byte Winchester subsystem with tape back-up.

The New 8000 SX Micro Computer System With Winchester And Floppy And Tape

Winchester technology brought a tremendous increase in capacity, but it also dumped a big problem in your lap.

How to dump all that data?

Trying to transfer 10 to 40M bytes of data between Winchester and floppies takes an armload of diskettes and a lot of time.

Cartridge tape is fast, but not efficient for random file handling.

Answer?

The new 8000 SX Micro Computer System with Winchester plus Floppy and Tape. It lets you back up and restore a single file or a complete drive with maximum efficiency.

Choose from 10, 20 and 40M byte Winchester subsystems, with error detection and correction, capable of loading a 20K byte system program in less than a second.

The floppy subsystem offers up to 1.2M byte per 8" drive.

The bulk memory subsystem, an incremental cartridge tape drive, stores up to 17M byte on a single cartridge.

And, of course, the computer itself offers proven IMS top performance and reliability. Compare its full 2-year warranty.

Operating systems include CP/M, MP/M, and the incredibly powerful TurboDOS.

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2800 Lockheed Way, Carson City, NV 89701
Telex: 910-395-6051

Circle 186 on inquiry card.

is whisked to the beginning of the next line. This feature is particularly useful for the VIC-20 with its maximum line length of 22 characters. Without this word-wrap feature, the screen would quickly become cluttered with many word fragments at the beginnings and ends of lines. (A 40-character-line software option for the VIC-20 is under consideration. However, it would use a 3 by 5 dot matrix to form the characters and might be difficult to read.)

Half or full duplex: Half duplex means that the "echoplex" used by some data networks is not utilized. Communication still takes place in two directions on two frequency-multiplexed "channels," but the host computer no longer echoes what the user types. Instead, the VIC-20 displays what the user types directly on its own screen. This feature is also menu-selectable.

Color separation: In the half-duplex mode, the software can display what the user types in one color, while displaying the host computer's output in another color. This feature makes user-computer dialogues easier to read.

Data rate: This selection on the menu goes from 0 to 300 bps. Some data-communications aficionados may turn up their noses at a data rate of 300, but most economy modems do not exceed it. Three hundred bps translates into 300 five-letter words per minute. This is faster than most of us type and faster than a radio announcer can read.

Five parity settings: These are also menu-selectable. They are: even parity, odd parity, parity set to one (mark), parity set to zero (space), and no parity (eighth bit treated as data). This feature goes a long way toward assuring that the modem will make the VIC-20 compatible with most 8-bit-byte transmission schemes. More on this feature later.

By now, a cartridge with even more features should be available, priced around $50.

If you decide not to buy the VICTERM I software, Commodore provides a free printed copy of a short BASIC program with the modem (see listing 1). You key this program in before dialing and eventually record it on your own cassette. It has none of the features listed above for the VICTERM I software.

What do engineers at large data networks recommend when using an inexpensive modem to connect to their expensive computers? Mike Marburger, Tymnet's Eastern Region Technical Manager, recommends setting parity to zero (space) on the modem and typing control-H immediately after the Terminal Identifier (TID) to disable Tymnet's

At a Glance

Name
VICMODEM

Use
Telecommunications for the VIC-20

Manufacturer
Commodore Business Machines Inc.
681 Moore Rd.
King of Prussia, PA 19406

Dimensions
Approximately 15 by 10 by 3.75 cm (6 by 4 by 1½ inches)

Price
$109.95 (includes $9.95 VICTERM I cassette software)

Hardware Needed
VIC-20, modular telephone, television set or video monitor, cassette recorder

Software Needed
VICTERM I cassette software or cartridge equivalent

Hardware Options
If you already own an acoustic coupler, it can be used with Commodore's RS-232 interface

Features
Direct connection to VIC-20 and telephone, crystal control, carrier-detect LED, originate/answer switch. With VICTERM I: word wrap, color separation (see text), menu-selectable data rate, parity options, cursor (on/off)

Documentation
User-friendly, step-by-step, illustrated manual

Audience
Anyone desiring an inexpensive telecommunication device

Pascal Computer Design

Volume No. 4 **PENN YAN, NEW YORK** **25 CENTS Cheap**

IMP Debuts

A Generation Beyond MuMath and FORTRAN

Penn Yan- Programmer/Engineer John Clarke has released his IMP (Instant Mathematical Programming) for use with all UCSD p-System machines, as well as for CP/M users with Pascal/M. The program, which was introduced at $225, permits anyone (yes, a non-programmer) to generate sophisticated Pascal programs to solve complex linear and non-linear equations.

IMP Writes It

The IMP software first simplifies an algebraic problem statement (entered in simple text form), then writes a Pascal source program which, when compiled, gives the user a solution. The compiled program then permits the user to *Interactively* redefine constants or variables, or to maximize given parameters. Reviewers claim this system may replace FORTRAN as the engineer's computer standard.

TURNKEY CHEAPER THAN CP/M

Eliminate Need for Operating System Boot to Run Applications Approach *(End Users Relieved)*

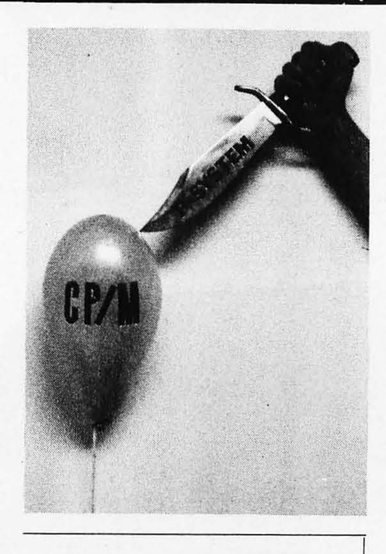
P-System Turnkey Packages are now available for applications developers to distribute with their programs. The software allows the end-user to "Boot and Run" without needing to learn about operating system commands. Full backup, editing and file handling capabilities also available at a fraction of the full system cost. This should prove to be a boon to systems houses...and it's cheaper than CP/M!

LOGICALC (TM) moves "Calc" Software to UCSD Environs

LOGICALC (TM) gives spreadsheet capability to all those other micros. Does

-Does Regression Analysis
-Accepts Database In-Out

Penn Yan- Logicalc (TM) has swept the Pascal world by storm. Only $295 a complete package.



RADIO SHACK II, III GET p-SYSTEM

Now Can Share Programs with Apple, DEC and IBM

Penn Yan- PCD Systems, who originally installed the p-System on the TRS-80 Model II have announced release of the complete system for the TRS-80 Model III. The p-System requires a 48K Model III with 2 disk drives. Now Radio Shack users can write programs compatible with Apple, Commodore, IBM (Personal Computer) and DEC machines (and vice versa).

A spokesman from the company noted that p-System software for DEC, Altos, Terak and Apple are already available from PCD Systems, Inc.

Chapin Refuses to Reveal True Meaning of CPR

Penn Yan- Chip Chapin, who recently released his CPR "text formatter" refuses to reveal the true meaning of his new program's title.

CPR, which was designed for use with the UCSD p-System operating system software, takes raw text files produced from the Editor and formats them for printing. At $195, CPR provides sophisticated word processing capabilities for a fraction of the cost.

So, when someone mentions CPR, don't think "first aid", think "text aid".

Now available at PCD Systems, Inc.

§CP/M is a tm of Digital Research
‡DEC, PDP-11, LSI-11 & RT-11 are tm of Digital Equipment Corp.
•MuMath is a tm of Microsoft
*p-System is a tm of the Regents of California
†TRS Model II, III & TRSDOS are tm of the Tandy Corp.
★Z-80 is a tm of Zilog Corp.

UCSD p-System To Burst CP/M's Balloon

Experts predict 8-Bit to 16-Bit Portability Crucial

Support from IBM, Texas Instruments, Philips, Hewlett Packard, Commodore Announced

San Diego- Sources close to the battle predict that recent Version IV.O release and the master design that allows programs compiled on an 8-bit machine to run unchanged on the new 16-bit micros will give the p-System the "industry standard" status presently enjoyed by CP/M. They say that SofTech and PCD Systems have come up with the most viable system for the 80's.

Cross assemblers and "Pseudo-Code" allow programs developed on an 8-bit 6502 (such as Apple or Commodore) to be transported to a 16-bit 8088 (IBM) or LSI-11 (DEC) in **OBJECT CODE FORM.** A program can be executed without change on dozens of different machines with any common terminal.

Structured Programming lowers Maintainence Costs

P-System structured languages give developers powerful tools. A complete implementation of Pascal (plus many useful extensions) is available, as is FORTRAN-77, which supports the ANSI-77 subset for that language. A new BASIC compiler and a full range LISP interpreter round out the high level languages available. The structured approach to programming eliminates maintenance headaches which plague present users of standard BASIC and FORTRAN systems.

Speed No Longer an Issue

Linkage of Code segments in assembly language and/or use of the **NATIVE CODE** generators give compact code *without the sacrifice of speed* expected from p-Code interpretation. One can have one's cake and eat it too!

Dynamic Memory Management

Virtual operating system characteristics with nearly unlimited overlaying of program segments allows the user to run larger programs than other microcomputer operating systems. Program chaining, print spooling, 128K addressing capability and efficient use of system library units, universal screen control coding, and many peripherals configurations are fully supported. Command files, asynchronous I/O processing, p-Code debugger, procedural cross referencer and many more capabilities are being hailed by thousands of users.

20% Off List

Penn Yan- PCD Systems is giving purchasers 20% off SofTech Microsystems suggested list price for those who buy a complete UCSD Development System by July 1st. Operating System, File Handler, Screen Editor (with word processing capabilities) system Library, Assembly Code Linker, Pascal Compiler and full documentation *over 1000 pages* is being sold for only $600 complete. Compare other systems of this power and capability at three times the price!

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Circle 307 on inquiry card.

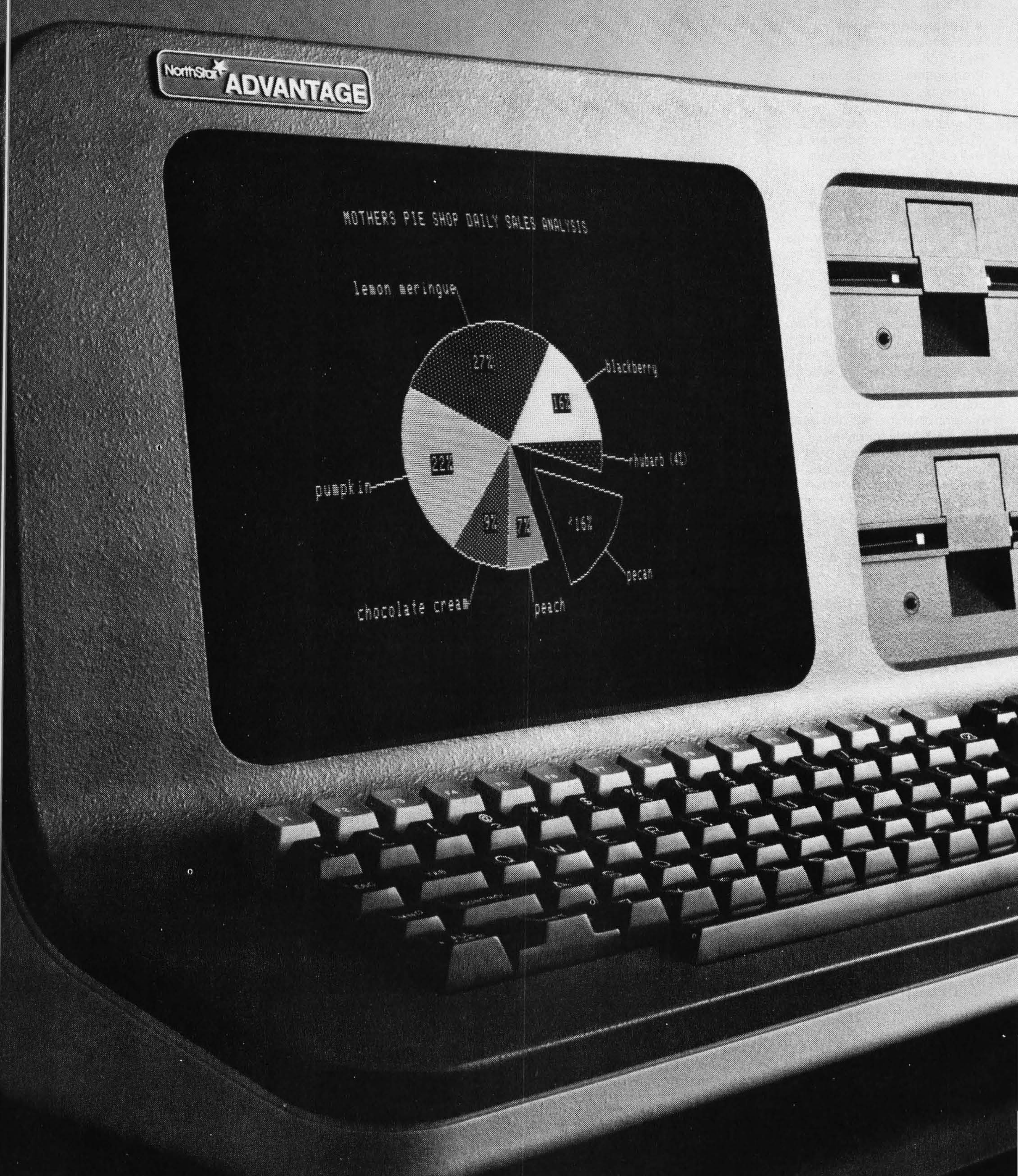
Cross Assemblers, File Conversion Transfer

A complete set of native code generating cross assemblers generate absolute or relocatable code for the Z-80, Z-8, 8080, PDP-11, LSI-11, 6502, 6800, 6809 and 9900 microprocessors and are available through PCD Systems. File conversion programs for transferring data between TRSDOS, CP/M, RT-11, Microengine and IBM 3741 formats and p-System format add depth to system capabilities.

Complete Portable Environment

The standard p-System still includes that amazing screen editor (with its programming and word processing modes), file handler, interpreter, formatter, backup and configuration programs, and your choice of compiler. PCD Systems together with UCSD and SofTech have advanced the state of the art!

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	NORTH STAR ADVANTAGE	IBM PERSONAL COMPUTER	APPLE III
MICROPROCESSOR(S)	Z-80A Central processor 8035 Auxiliary processor	8088 processor	6502A processor
GRAPHICS DISPLAY RESOLUTION	640x240 pixels	640x200 pixels	560x192 pixels
DUAL FLOPPY DISC CAPACITY	720K bytes	320K bytes	280K bytes
CONVENIENT DESKTOP PACKAGE*	Yes, all in one enclosure	No, 3 enclosures	No, 3 enclosures
BUSINESS GRAPHICS SOFTWARE INCLUDED?	Yes	No	No
CP/M COMPATIBLE?	Yes	Partial	No
LANGUAGES SUPPLIED BY MANUFACTURER	Graphics BASIC, PASCAL, COBOL, FORTRAN, C	BASIC, PASCAL	BASIC, PASCAL
APPLICATIONS S/W PACKAGES SUPPLIED BY MANUFACTURER	10 packages	5 packages	5 packages
SELF-TEST DIAGNOSTIC	Yes	Yes	No
NATIONAL ON SITE SERVICE	Yes	No	No
MANUFACTURER SUPPLIED PRINTERS	Letter quality/matrix (136 columns)	Matrix (80 columns)	Letter quality/matrix (80 columns)
RETAIL PRICE PER KILO-BYTE OF DISK STORAGE	$5.55	$11.17	$15.57

*Professional configuration: Dual Floppy Disks, Monochrome Display, Keyboard, CPU, 64K bytes (or minimum) RAM Memory, and Printer Interface.
Source: Dataquest and Manufacturer's Literature, November 1981.



Circle 281 on inquiry card.

Listing 1: *A simple BASIC program that allows the Commodore VIC-20 to communicate using the modem. VICTERM I, a more sophisticated program, is available at extra cost.*

```
100 OPEN5,2,3,CHR$(6):DIMF(255),T(255)
210 FORJ=32TO64:T(J)=J:NEXT:T(13)=13:T(20)=8:RV=18:CT=0
220 FORJ=65TO90:K=J+32:T(J)=K:NEXT:FORJ=91TO95:T(J)=J:NEXT
240 FORJ=193TO218:K=J-128:T(J)=K:NEXT:T(146)=16:T(133)=16
260 FORJ=0TO255:K=T(J):IFK<>0THENF(K)=J:F(K+128)=J
270 NEXT:PRINT"▯
300 GET#5,A$:SR=ST:IFA$=""ORSR<>0THEN310
305 PRINT" ▮"CHR$(F(ASC(A$)));:IFF(ASC(A$))=34THENPRINTCHR$(34);
306 GOTO300
310 PRINTCHR$(RV)" ▮▀";:GETA$:IFA$<>""THENPRINT#5,CHR$(T(ASC(A$)));
315 CT=CT+1:IFCT=8THENCT=0:RV=164-RV
320 IF(PEEK(37151)AND64)=1THEN320
330 GOTO300
```

default (automatic) echo state. Tymnet can, at the interface to a host computer (not a terminal or home computer), routinely strip parity coming in from terminals and microcomputers and put on whatever type of parity the host computer requires.

General Electric Information Services Company operates a network similar to Tymnet, although GE's is much larger. In fact, it is the largest international data-communications network in the world. Robert McCalley, manager of the communications and distribution system, recommends setting the modem to half duplex and no parity (treating the eighth bit as data) before logging on.

Keith Boyer, a spokesman for Compuserve's technical services, noted that although *any* parity setting will put ASCII characters on the screen, the eighth bit must be sendable and receivable as data in order for Compuserve's A and B file-transmission protocols to work properly. These protocols are used for important functions such as downloading programs to user memory. Also, transmission of some graphics characters requires the eighth bit. The "no parity" selection on the VICTERM I menu should be selected when using the A and B protocols or graphics programs.

As this article was being completed, The Source had some information for VIC users in its Commodore Business Machines database.

The VICMODEM was developed under the watchful eyes of Michael Tomczyk. The development process took four months from start to finish, he said in a recent interview. The toughest part was bringing it in at the right price. Tomczyk, who has an astute sense of the marketplace for home computers, assessed the future of the modem this way: "We think this modem may sell as many VICs as the game cartridges."

With a growing number of giant publishing firms gearing up to supply electronic newspapers, videotex, and other home data products, he may well be right. ■

Lowercase Descenders for the Epson MX-70

Bruce Piggott
35 Beverley Rd.
Stevenage, Hertfordshire
SG1 4PR, England

Like most home-computer owners, I wanted a printer and, like most, couldn't afford one. But as prices began to fall, I gradually realized I could afford the Epson MX-70.

The MX-70 uses ordinary paper and has a graphics mode, but unfortunately it does not do lowercase descenders. This didn't worry me too much because most of the printing I wanted to do was program listings.

However, after working with the printer, I realized that although the MX-70 has eight print wires, it uses only seven in text mode. That meant lowercase descenders would be possible by switching to the graphics mode at the right time and using all eight print wires to create the lowercase letters.

Strangely enough, the MX-70 can print true descenders mechanically, but electronically the option was not available. I decided to write a machine-language program to modify the output.

The technique is to have a small program that examines the output of a printing routine. It looks at the ASCII (American Standard Code for Information Interchange) character in the microprocessor's A register to see if it is a lowercase letter with descender (e.g., g, j, p, q, or y). If one of those letters is not in that register, then the program jumps to the standard output routine and prints the character in the normal way.

If, however, the letter requires a lowercase descender, the program switches the printer into the graphics mode and outputs a string of data that drives the printing pins to construct the improvised character (see listing 1).

The program assumes that the printer controller card is in slot 1. The equates (EQU) in lines 19, 20, and 21 must be changed for other slots: for slot 2, add hexadecimal 100 to the numbers, for slot 3, add hexadecimal 200, and so on.

If the character style is not to your liking, it can be changed by modifying the appropriate data string. The format is 5 dots wide and 8 dots deep, with the first byte defining the left side of the character and with the most significant bit at the top. The data string must end in a zero, as this is the delimiter for the program.

The program can also be extended to modify other characters or create some that are not in the standard ASCII set, for example:

- to change the number sign (#) to the English pound sign (£)
- to intercept normally unprintable codes (0 through 7) and print graphics
- to print Chinese characters

Plan the character you wish to design on graph paper. Convert the vertical columns into hexadecimal values using the tables in the MX-70 operation manual (remember the top bit is most significant). Then insert the resulting string into the source code in the DATA1 file (line 93), and insert the representative ASCII code into the "match" string (line 87). If you add a string at the end of the DATA1 file, you must also place the matching ASCII code at the end of the match string.

The program resides at hexadecimal 300 (decimal 768) and this address will have to be entered into the printer driver program.

Anyone planning to use this technique should expect that the operation of the MX-70 will seem a little strange at first. Whenever the MX-70 enters the graphics mode, it completes printing whatever is in the buffer up to that point, then backsteps to print the graphics. Consequently, the speed of the printer will slow down proportional to the number of lowercase letters with descenders. For this reason, I use the routine only for the final copy.

But the combination of the MX-70 and this program has saved me over $150 compared to the price of the MX-80. And now I also have the use of the graphics mode. ■

Listing 1: *The Lowercase Descender program for the MX-70 and Apple II. Not only can you get true lowercase descenders, but you can program your own characters.*

```
SOURCE FILE: MX-70
0000:            ************************************************************
0000:            * LOWER CASE DESCENDERS FOR MX-70
0000:            *
0000:            * PROGRAM INTERCEPTS LOWER CASE :- G,J,P,Q,Y AND
0000:            * USING BIT MODE GRAPHICS, CONSTRUCTS TRUE
0000:            * DESCENDING CHARACTERS.
0000:            *
0000:            * PROGRAM ASSUMES THAT PRINTER INTERFACE-
0000:            * IS IN SLOT ONE. FOR OTHER SLOTS CHANGE-
0000:            * PRINTER,POUT AND PSENSE EQUATES.
0000:            * EG. FOR SLOT TWO ADD HEX. 100 TO ALL THREE EQUATES.
0000:            *
0000:            * BRUCE PIGGOTT. 6/20/81
0000:            *
0000:            ************************************************************
0000:            *
FF4A:            SAVE    EQU   $FF4A      :SAVE ALL REGISTERS
FF3F:            RESTORE EQU   $FF3F      :RESTORE ALL REGISTERS
C102:            PRINTER EQU   $C102
C090:            POUT    EQU   $C090
C1C1:            PSENSE  EQU   $C1C1      :SWITCHED ROM LOCATION
0000:            *
0000:            * MAIN PROGRAM ENTRY POINT
0000:            *
----- NEXT OBJECT FILE NAME IS MX-70.OBJ0
0300:                    ORG   $300
0300:20 4A FF    ENTER   JSR   SAVE       : THIS ROUTINE SAVES ALL
0303:            *                          REGISTERS BUT DESTROYS THE
0303:            *                          CHARACTER IN THE 'A' REG.
0303:A5 45               LDA   $45        : REPLACE CHAR. FROM IT'S STORE.
0305:A2 04               LDX   #4         : SET UP X AS COUNTER FOR CHAR. SCAN
0307:DD 6E 03    LOOP1   CMP   MATCH,X    :COMPARE CHAR WITH MATCH LIST + X
030A:F0 09               BEQ   MODIFY     :IF IN LIST.X REG TELLS WHICH
030C:CA                  DEX
030D:10 F8               BPL   LOOP1      : IF X NOT < 0
030F:20 3F FF            JSR   RESTORE    : IT WAS NOT IN LIST SO RESTORE
0312:4C 02 C1            JMP   PRINTER    :-- AND GO TO STANDARD ROUTINE
0315:            *
0315:            ************************************************************
0315:            *
0315:            * THE CHARACTER HAS BEEN IDENTIFIED AS G,J,P,Q OR Y
0315:            * THE X REGISTER IDENTIFIES WHICH.
0315:            * FIRST STEP IS TO MULTIPLY X BY 6 SO THAT IT CAN BE USED
0315:            * AS AN IDEXED OFFSET TO THE DATA LIST.
0315:            *
0315:8A          MODIFY  TXA              :PUT X IN A TO ALLOW MANIPULATION
0316:0A                  ASL   A          : DOUBLE A
0317:8D 6D 03            STA   SUM        :STORE RESULT
031A:0A                  ASL   A          : QUADRUPLE A
031B:18                  CLC              : CLEAR CARRY FOR NEXT ADD
031C:6D 6D 03            ADC   SUM        : 4XA + 2XA = 6XA
031F:48                  PHA              : SAVE RESULT FOR LATER
0320:            *
0320:            * NOW PUT PRINTER IN BIT MODE FOR  6 BYTES
0320:A2 03               LDX   #3         : COUNTER
0322:BD 4B 03    LOOP2   LDA   DATA0,X    : GET NEXT DATA0
0325:8D 90 C0            STA   POUT       : SEND TO PRINTER
0328:20 43 03            JSR   SENSE      : WAIT TILL PRINTER DONE
032B:CA                  DEX
032C:10 F4               BPL   LOOP2      : IF NOT DONE
```

Listing 1 continued on page 254

INTERESTED?



LET'S TALK

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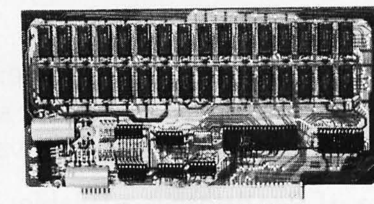
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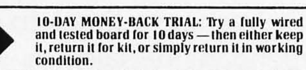


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five	forty	400hertz tone	feet	left	out	speed	g	x
six	fifty	80hertz tone	flow	less	over	star	h	y
seven	sixty	20ms silence	fuel	lesser	parenthesis	start	i	z
eight	seventy	40ms silence	gallon	limit	percent	stop	j	
nine	eighty	80ms silence	go	low	please	than	k	
ten	ninety	160ms silence	gram	lower	plus	the	l	
eleven	hundred	320ms silence	great	mark	point	time	m	
twelve	thousand	centi	greater	meter	pound	try	n	
thirteen	million	check	have	mile	pulses	up	o	
fourteen	zero	comma	high	milli	rate	volt	p	
fifteen	again	control	higher	minus	re	weight	q	
sixteen	ampere	danger	hour	minute	ready	a	r	
seventeen	and	degree	in	near	right	b	s	

ADDITIONAL VOCABULARY NOW AVAILABLE (VOX II)

abort	complete	fifth	light	put	station
add	continue	fire	load	quarter	switch
adjust	copy	first	lock	range	system
alarm	correct	floor	longer	reached	temperature
alert	crease	fourth	more	receive	test
all	"de"	forward	move	record	"th"
ask	deposit	from	next	reverse	thank
assistance	dial	gas	no	red	third
attention	door	get	normal	repair	this
blue	east	going	north	repeat	turn
brake	"ed"	green	not	replace	under
button	emergency	hale	notice	room	use
buy	enter	heat	open	safe	waiting
call	entry	hello	operator	second	warning
called	"er"	help	or	secure	was
caution	"eth"	hurts	pass	select	water
celsius	evacuate	hold	per	send	west
centigrade	exit	hot	power	service	wind
change	fail	in	press	side	window
circuit	failure	incorrect	pressure	slow	yellow
cigar	fahrenheit	intruder	process	slower	yes
close	fast	key	pull	smoke	zone
cold	faster	level	push	south	

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Signature ________
Print Name ________
Address ________
City ________
State ________ **Zip** ________

Listing 1 continued from page 249:

```
032E:           *
032E:           * NOW OUTPUT CHARACTER DATA
032E:           *
032E:68                 PLA              : GET OFFSET TO CHAR.
032F:AA                 TAX              : PUT IN X AS INDEX
0330:BD 4F 03   LOOP3   LDA  DATA1,X     : GET NEXT CHAR. DATA
0333:C9 00              CMP  #0          : DELIMITER?
0335:F0 09              BEQ  EXIT        : IF DONE
0337:8D 90 C0           STA  POUT        : SEND TO PRINTER
033A:20 43 03           JSR  SENSE       : WAIT TILL PRINTER DONE
033D:E8                 INX
033E:10 F0              BPL  LOOP3       : IF NOT DONE
0340:           *
0340:           * ALL DONE SO EXIT VIA RESTORE ROUTINE
0340:           *
0340:4C 3F FF   EXIT    JMP  RESTORE
0343:           *
0343:           ***************************************************************
0343:           * SUB ROUTINE TO SENSE THAT PRINTER HAS
0343:           * FINISHED PRINTING LAST CHARACTER.
0343:           ***************************************************************
0343:           *
0343:AD C1 C1   SENSE   LDA  PSENSE      : GET PRINTER STATUS
0346:C9 FE              CMP  #$FE        : STILL BUSY ?
0348:F0 F9              BEQ  SENSE       : IF YES
034A:60                 RTS              : IF PRINTER READY
034B:           *
034B:           *
034B:           ***************************************************************
034B:           * DATA GROUPS
034B:           *
034B:00 06 4B   DATA0   DFB  0,6,$4B,$1B : CONT.K,6 IN REV.ORDER
034E:1B
034F:           *
034F:18 25 25   DATA1   DFB  $18,$25,$25,$25,$5A,0 :G DATA
0352:25 5A 00
0355:02 01 21           DFB  2,1,$21,$BE,$20,0 : J DATA
0358:BE 20 00
035B:3F 24 24           DFB  $3F,$24,$24,$24,$18,0 : P DATA
035E:24 18 00
0361:18 24 24           DFB  $18,$24,$24,$24,$3F,0 : Q DATA
0364:24 3F 00
0367:39 05 05           DFB  $39,5,5,5,$3E,0 : Y DATA
036A:05 3E 00
036D:           *
036D:00         SUM     DFB  0           :SCRATCH DATA
036E:           *
036E:E7 EA F0   MATCH   DFB  $E7,$EA,$F0,$F1,$F9 :G,J,P,Q,Y
0371:F1 F9
0373:           *
0373:           * END OF SOURCE
0373:           ***************************************************************
0373:           * TEST ABOVE ROUTINE
0373:           ***************************************************************
0373:A9 54      TEST    LDA  #$54        : 'T'
0375:20 02 C1           JSR  PRINTER
0378:A9 F9              LDA  #$F9        : LOWER CASE "Y"
037A:20 00 03           JSR  ENTER
037D:A9 0A              LDA  #$A         : LINEFEED
037F:4C 02 C1           JMP  PRINTER     : EXIT VIA PRINTER
0382:           ***************************************************************

*** SUCCESSFUL ASSEMBLY: NO ERRORS
```

Add a Full-Sized Keyboard to Sinclair's ZX80

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Swinburne Institute of Technology
POB 218
Hawthorne 3122
Swinburne, Australia

The Sinclair ZX80 keyboard has several obvious limitations. After only a short period of use, the user will begin to realize that the keyboard is awkward and doesn't really allow any degree of speed. Another limitation is not so obvious: the lack of a true reset button. This may not be apparent when running BASIC programs, as the break key works well, but a reset button is necessary when running machine-code programs or subroutines. Thankfully, all of these limitations can be eliminated (see photo 1).

Adding the Keyboard

The ZX80 decodes its keyboard by software. To the processor, the keyboard appears as a block of I/O (input/output) ports. The upper 8 bits of the address bus, A8 through A15, are apparently used to strobe the keyboard sequentially, and the resulting values on the data bus are decoded. Figure 1 shows this interconnection as it appears from the back (solder side) of the ZX80 printed-circuit board. If software makes address line A9 high while the A key is pressed, D1 will be high, but D0



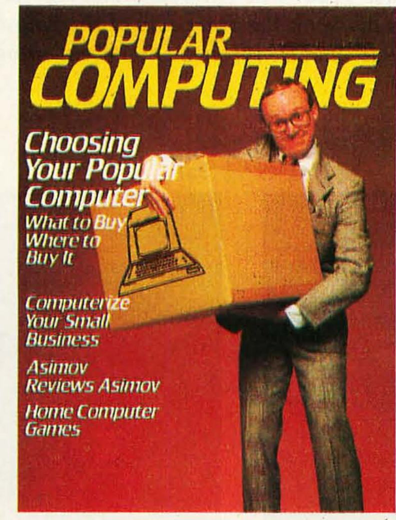
Photo 1: *The ZX80 in operation with its new keyboard.*



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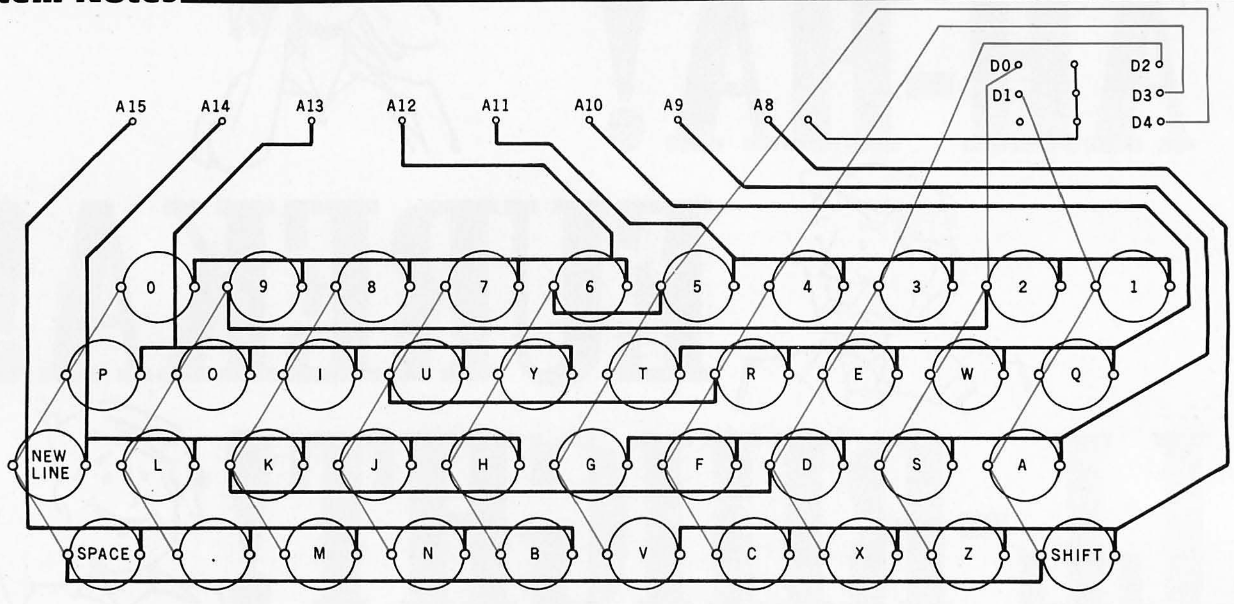
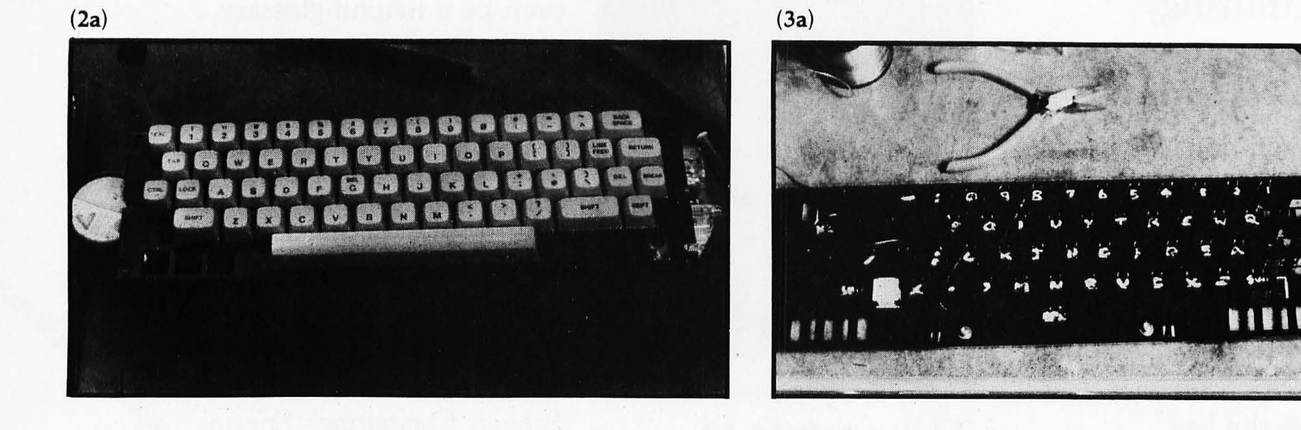


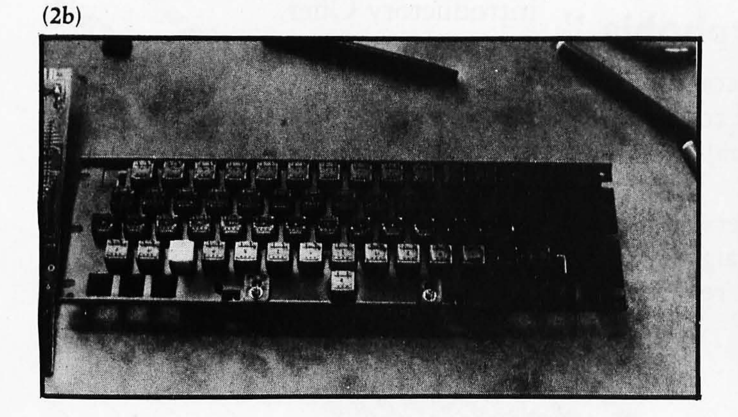
Figure 1: *The connection of keys on the Sinclair ZX80 keyboard. The black lines represent actual traces on the "solder side" of the printed-circuit board. The red lines are connections made on the other side of the board. The ribbon-cable connection to the new keyboard is made to the points labeled A8 through A15 and D0 through D4. When wiring the new keyboard, all connections should follow this diagram.*

(2a)

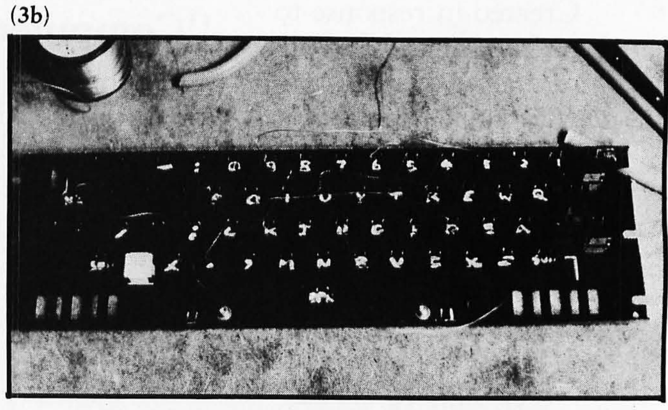
(3a)



(2b)



(3b)



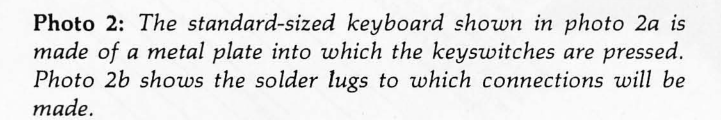


Photo 2: *The standard-sized keyboard shown in photo 2a is made of a metal plate into which the keyswitches are pressed. Photo 2b shows the solder lugs to which connections will be made.*

Photos 3a and 3b: *Wiring the new keyboard. Photo 3a shows the first set of installed jumpers. The wire is standard 30 AWG wrapping type, wrapped once around each post before soldering. Photo 3b shows the completed jumper system.*

and D2 through D4 remain low.

Photo 2a shows the keyboard I used, consisting of a metal base with holes into which the keyswitches are pushed. Two solder lugs on the back of each keyswitch make the connections (see photo 2b). Many of the symbols that are unshifted on a normal keyboard are obtained by using the shift key on the ZX80; consequently a number of keys on the new keyboard will not be used.

The first step is to wire the keys together (use figure 1 as a guide). Keys do not have to be arranged as they are on the ZX80, as long as the connections remain the same, and two or more keys may be used for the same function by wiring them in parallel (i.e., wire one as shown, then wire the two posts of the second key to the corresponding posts on this first key—I did this with the shift key to use the second shift key on the keyboard). Photo 3 shows how to wire the keys together. I used striped Kynar (wire-wrap) wire to make the connections and insulating tape to shield the wires where necessary. A connector may be added to the free end of the ribbon cable.

The second step involves the connection at the ZX80 end. The ribbon cable should be carefully soldered to the points shown in photos 4a through 4c, then extra solder added to obtain a good connection. Avoid applying too much heat as it can damage the board or solder pads. Again, a connector can be added to the ribbon cable.

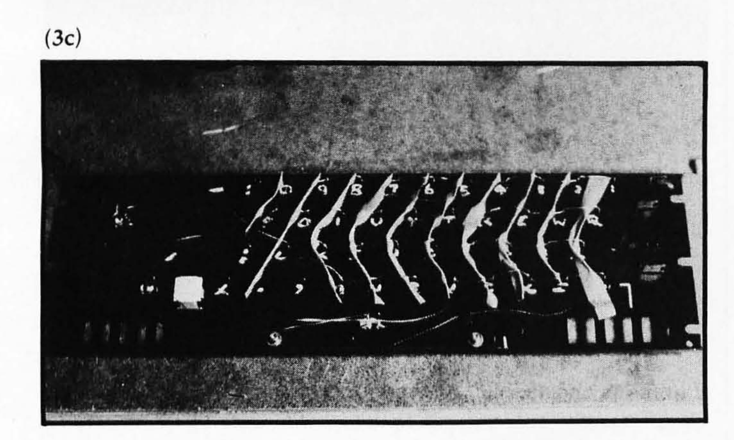
Once the final connection is made, you're ready to test the keyboard. If you have problems, recheck your wiring on the new keyboard for a short circuit or broken connection. I had no such problems—the keyboard worked perfectly from the start. One potential problem, key bounce, never arose. Apparently the touch-sensitive keys on the ZX80 aren't as prone to this phenomenon as other keyboards. A constant worry was that the technique the ZX80 used to handle key bounce would not allow sufficient time for the key bounce on the new keyboard to settle down. In practice, however, this was not a problem.

Adding the Reset Key

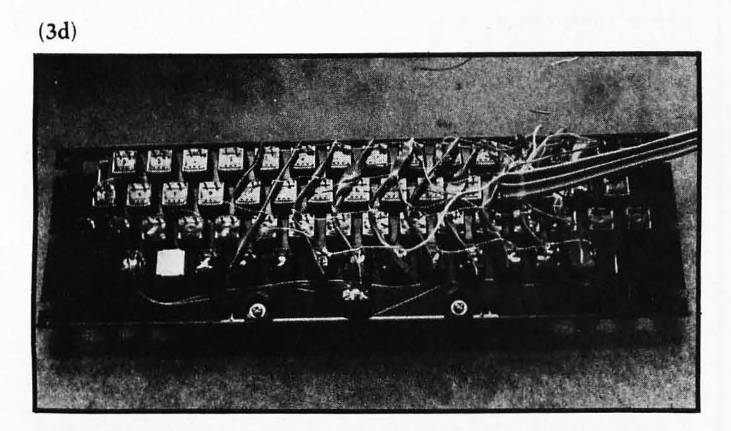
To reset, simply connect the reset pin of the Z80A processor, pin 26, to ground. There are two ways of doing this. The first uses the expansion bus. Pin 21A on the component side is the reset line, and pins 4B and 5B on the solder side are ground. All that is required is to connect a momentary contact switch between these two pins.

The second technique involves making these connections closer to the processor. I chose this approach because connections had already been made on the

(3c)

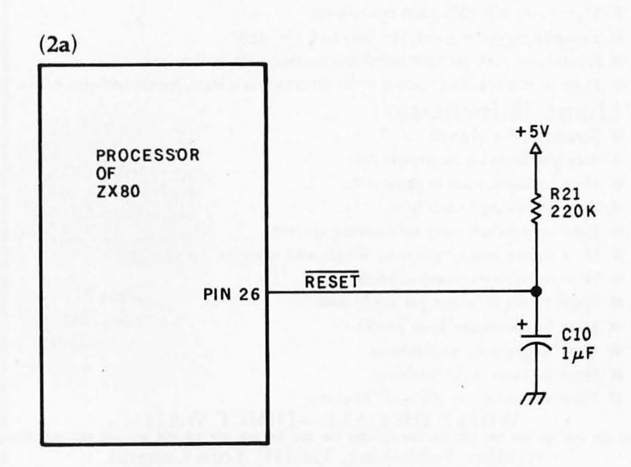


(3d)



Photos 3c and 3d: *Extra insulation is added in photo 3c, and photo 3d shows the installed ribbon cable.*

(2a)



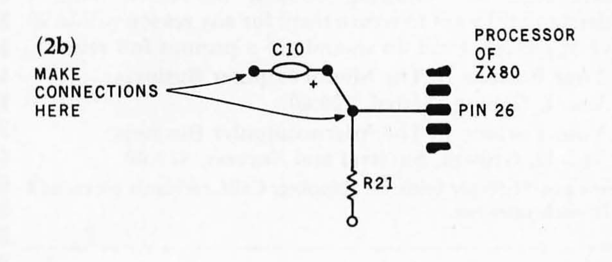
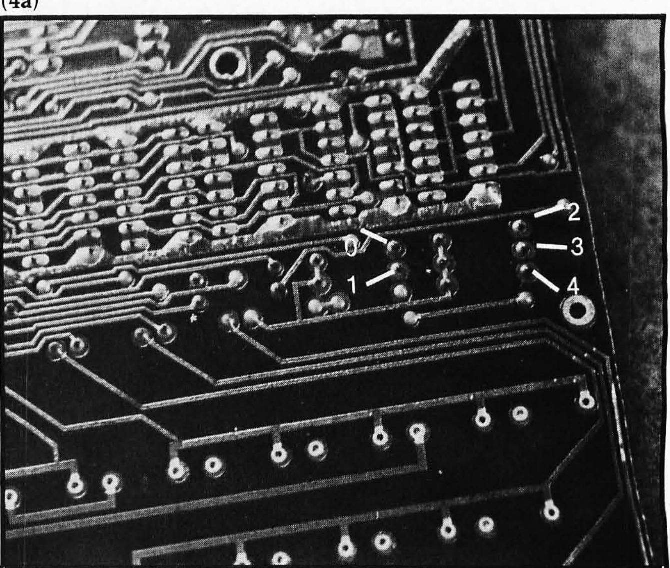
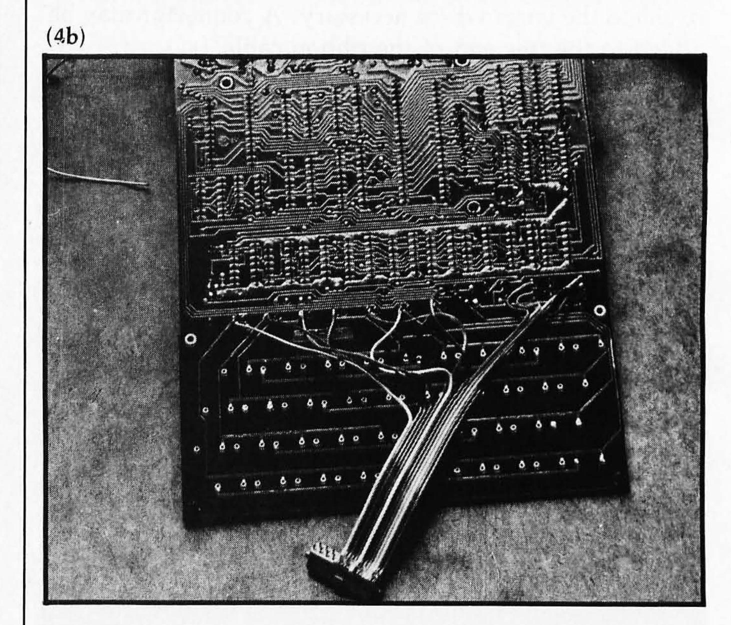


Figure 2: *Diagram of the reset system used in the ZX80. Figure 2a is a schematic representation of the reset circuitry. Figure 2b is a sketch of the solder side of the circuit board where the connection to the reset key is made.*

(4a)



(4b)



Photos 4a and 4b: *Ribbon-cable connections to the ZX80. Photo 4a shows the solder pads to which the data-bus connections should be made (labeled 0 through 4). Photo 4b is the completed ribbon-cable connection.*

underside of the board for the keyboard, so two more didn't matter.

Pull-up resistor R21 and capacitor C10 on the ZX80 are connected to the reset pin of the processor (see figure 2a). Thus, the reset switch can be connected between pin 26 of the processor and the grounded side of the capacitor (see figure 2b). I ran two lines with the ribbon cable to the keyboard I had added and connected *two* spare keys in series such that both have to be pressed together for a reset. This minimizes the chance of an accidental reset.

These simple modifications greatly increased the accuracy, speed, and ease of use of the Sinclair ZX80, and neither process is beyond the ability of anyone who has used a soldering iron on printed-circuit boards.■

Photo 4c: *The pads to which the address lines should be connected.*

Text Editing with Compuview's VEDIT

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Department of Chemistry
University of Toledo
Toledo, OH 43606

VEDIT is a fast, friendly, adaptable, full-screen editor for use with CP/M and compatible operating systems. It is the first software product from Compuview, based in Ann Arbor, Michigan. If you're writing programs on the editor that came with CP/M, and particularly if you've never used a full-screen editor, then what follows will probably be of interest to you. With VEDIT, you always have a full screen of text in front of you. To add or change, you just type. If this review gives you an appetite for simplicity while editing, then VEDIT, at $130, is well worth considering.

If you already own a word processor or a full-screen editor, you might still be interested in VEDIT. It's very adaptable to your video-display terminal, to your preferences in assigning special keys, and to the task at hand. I keep three versions: one for general text writing, one for BASIC programming, and one for assembler programming. (More about this under Customization.) VEDIT performs best as a programmer's editor. You can write notes, letters, and even manuscripts on it, but VEDIT is not a word processor.

What It's Like to Use VEDIT

VEDIT has two operating modes: a command mode (which works like a conventional command editor) and a visual mode. In visual mode, the screen is filled with a portion of the text. Most work is done in visual mode, so I'll describe that first.

The portion of text on the screen is called the *window*. I began the final version of this article by giving CP/M the command:

```
VEDIT BYTVEDIT.REV
```

If the file BYTVEDIT.REV had not existed, the message NEW FILE would have appeared briefly, after which the screen would have been cleared, with the cursor at upper left ready for entry of text. Until you have a change or correction to make, you just type in your text. In this case, the file already existed, so the window filled with the first lines of the file, with the cursor at upper left. You can move the cursor over the window at will, adding, changing, or inserting text. If the cursor rests on existing text, what you type normally overwrites the old text. With one key, however, you can switch to an insert

At a Glance

Name
VEDIT

Type
Full-screen text editor

Manufacturer
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Price
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Format
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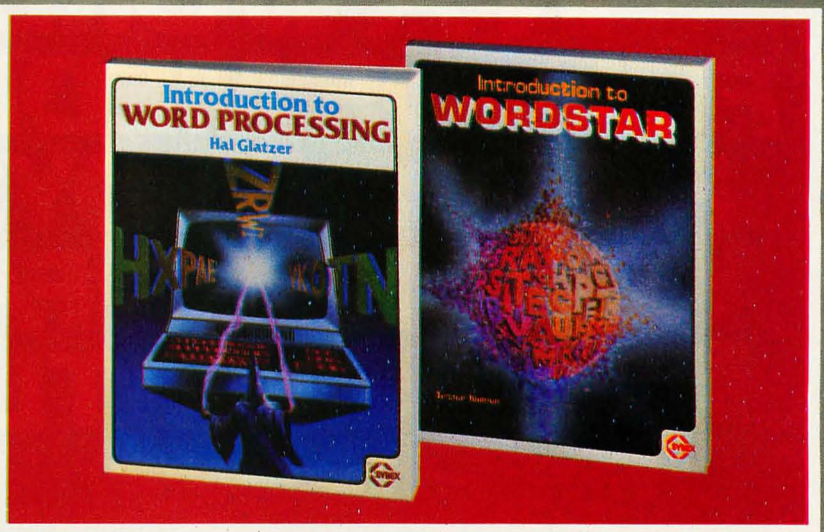
System needed
An 8080- or Z80-based computer with a video-display console and CP/M or CDOS operating system

Documentation
65 pages punched for 3-ring binder; approximately 15 pages of assembly-language listing also provided in two disk files

Audience
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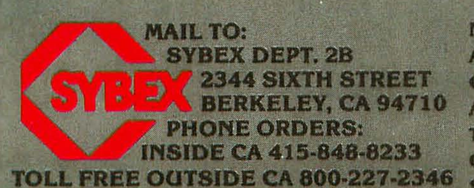
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mode, where the new text is inserted and everything to the right is shifted to make room.

Old text can be deleted by typing spaces over it (which leaves blanks), by backspacing (which moves the cursor left, deletes that character, and closes up the line), or by hitting Delete (which does the same without moving the cursor). In addition to the usual moves up, down, left, and right, VEDIT's cursor commands include single-key moves to the start or end of the current line, to the beginning of the next line, or to the next tab stop.

Once you've mastered on-screen maneuvers, how do you move the window? VEDIT has one-key instructions that page up or down a little less than one screen-height; others move the window and cursor to the beginning or end of the text. If you want to move up or down just a few lines, move the cursor up until it reaches the third line (or fourth or fifth, the value is set during customization). From that point on, additional Up Cursor keystrokes move the text down through the window (unless, of course, you're already at the beginning). Moving the cursor close to the bottom also scrolls the text up through the window.

An editor should be able to perform functions in addition to these on-screen manipulations. VEDIT handles these via an adequate command mode, which is designed to work nicely in tandem with the visual mode. For example, to replace every occurrence of the word OLD with the word NEW, the command string is:

#<S OLD $ NEW $> $$

The # means "do the contents of < > as often as necessary." S is the substitute command, and $ is echoed when the escape key is used. By adding a V command,

#<S OLD $ NEW $V>$$

VEDIT enters the visual mode after each substitution, with the cursor marking the point where the change was made. If the substitution is satisfactory, you press one key to return to command mode. Since the V command is inside the < >, you're immediately back in visual mode, with the cursor marking the next substitution. Of course, you may discover that you set up the substitute command incorrectly. VEDIT's author has provided another escape from visual to command mode, which jumps out of the < >.

Command mode has an adequate set of editing commands, considering you'll spend most of your time in visual mode. It also provides file-handling commands and a means for changing disks and escaping from write-error and full-disk situations. I made up a full disk for testing and VEDIT did indeed let me off the hook in two ways: by deleting a file to make space or by changing disks.

Customizing VEDIT

For those of us tinkering with new systems, VEDIT's strongest point may be its adaptability. The process is versatile, simple, and well documented.

VEDIT comes in versions for 8080 or Z80 processors and for serial interface or memory-mapped video displays. I've tested only the Z80, video-display version. You set up VEDIT by running a customization program called VEDSET, which leads you stepwise through the required choices. VEDSET first presents a list of nineteen popular terminals, including the Lear-Siegler ADM-3A, Heath H-19/Z-19, DEC VT52, Hazeltine, and Televideo, from which you identify your own. This lets VEDSET install the display-control escape sequences unique to your terminal, unleashing the speed made possible by those expensive features. If your terminal isn't included or if you've built your own, VEDSET provides special instructions and even an assembly listing of the terminal-dependent routines and tables.

I've done most of my testing of VEDIT on a North Star Horizon with 51K bytes of memory, two disk drives, and a Zenith Z-19 (alias Heath H-19) terminal. I've also used a Cambridge Development Labs Graphics Display plus a homebrew character

TO START OF BUFFER	PAGE UP	
Switch insert mode	Cursor up	Undent
TO START OF THIS LINE	NEXT TAB	TO END OF THIS LINE
Cursor left		Cursor right
TO START OF NEXT LINE	PAGE DOWN	TO END OF BUFFER
Indent	Cursor down	
COPY TO TEXT REGISTER	MOVE TO TEXT REGISTER	INSERT TEXT REGISTER

Figure 1: *Suggested keypad layout for Heath H-19 terminal. Shading (shifted keys) indicates large cursor movement and accompanying window movement as required. The H-19 should be set to Heath mode, the keypad shifted using internal switches and also set to Alternate keypad mode by including the sequence ESC = in the terminal initiation routine in the BIOS section of CP/M.*

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generator and terminal emulator, which provided a pretty rigorous test of those special instructions. VEDIT makes good use of smart terminal features when they're available. However, unforeseen questions may arise. For example, H-19 users should be aware that VEDSET assumes your H-19 is in "Heath Mode." If you've set the internal switch to "ANSI Mode," you'll want to set it back. It didn't take me long to work this out, but Compuview's literature, including the special sheet on the H-19, failed to mention it. Other terminals may have similar problems. The Compuview people urge you to contact them if you have trouble, and my experience indicates that they mean it. A phone call (on a different question) yielded technical assistance right away, and when things became complicated, I was connected with VEDIT's author, Ted Green.

The next step in customization is assignment of keys for cursor and window movements and for a dozen other special operations in visual mode. If your terminal has special function keys, you can assign them. You can also use any control character (except CTRL-M) or ESC followed by any letter. The assignment process is simple: VEDSET names the function, and you strike the key(s) you want to use. VEDSET will reject unsuitable choices. A sample layout for a keyboard without special keys is provided. My package included a suggested layout for the H-19, but I devised one I like better; its third revision is shown in figure 1. The instructions encourage you to try one of the sample setups and then revise it to suit yourself.

In the final segment of customization, you enter your screen size in characters, the number of lines up and down that you want the window to move when paging, and similar parameters. You can also set up two features of special convenience to programmers. First, there's a selective lowercase-to-uppercase conversion that operates on each line of text until some particular character is encountered. This lets you leave the caps lock off when entering programs, type your code in all caps, and type your comments in lowercase. VEDIT switches modes when it crosses the ; (semicolon) in 8080/Z80 code, the ' (apostrophe) in Microsoft BASIC, or the ! (exclamation point) in DEC BASIC Plus. This feature can be set up during customization and then altered during use from command level.

Second, there's Indent/Undent. You define a special key for Indent and another for Undent during setup and also specify an indent increment (say, 5 spaces). Each time you press the Indent key, it changes the position the cursor goes to when you press Return. One Indent and you return to position 6 instead of position 1; press Indent again and you now return to space 11, and so on. Each tap of the Undent key undoes one Indent. Even if the language you're writing doesn't require specific indents, this makes it easy to improve the readability of your code.

Other Special Features

A feature highly touted in VEDIT publicity is the Undo key. Whatever you've done on the line you're editing, one stroke on Undo and the whole line is restored—you're back

where you started. That seems like a good thing, but I don't use it much.

VEDIT also has a *text register* for moving or copying a block of text. Place the cursor at the beginning of the block, hit the Move key, move the cursor to the end of the block, and hit Move again. The block, now placed in the text register, disappears from the screen. You then move the cursor to wherever you want the text and hit the Insert key. Copy works the same way but doesn't delete the copied text from its original location. The Move key can also be used to delete a block of text.

One of VEDIT's best features is its speed in visual mode. VEDIT rarely rewrites the screen when it isn't necessary, and even when it does, the time required is not excessive. On the Z-19 at 9600 bps (bits per second), most operations seem instantaneous. Command mode, however, is another matter. A loop I set up to remove the first six characters from each line of a 200-line file took about 30 seconds.

VEDIT and Large Files

On my 51K-byte system, VEDIT's text buffer holds 35,786 bytes. (For comparison, Microsoft's EDIT80 holds 32,974, and Digital Research's ED holds 28,589.) That's almost 900 40-character lines. I rarely write single program modules that long, so I have limited experience with VEDIT's disk buffering for large files. On a 32K byte system, the buffer would hold about 17K bytes or over 400 lines.

Like most simple editors, VEDIT processes long texts by reading lines from an input file into the text buffer, where editing can take place, then writing into an output file. Progress is one-way. You can move the window at will over the text in the buffer, but once lines have been written to the output file, the entire text must pass through before the beginning can be reread.

VEDIT has command mode instructions to open and close files, to read and write lines, and to switch logged-in disks. There's even a single command to process the entire text and restart at the top of the file. However, these instructions aren't needed in the simplest cases. VEDIT does auto-buffering while in visual mode: if you page past the end of the buffer contents, the first lines are written to output and new lines are read from the input file. Normally, the buffer is no more than 80 percent full, leaving lots of room for insertions. VEDIT also writes to the output file if you fill the buffer by insertions.

My experience with other editors proved that supposedly legal operations could hopelessly scramble files on my disks. I've tried all the combinations that usually cause trouble, but VEDIT seems to handle them flawlessly.

What VEDIT Doesn't Do

I haven't found any serious bugs in VEDIT. A minor problem arises when you use the terminal's Repeat button to move the cursor around quickly or to delete a long string of characters. This works until VEDIT is required to do more than a simple operation. For instance, a repeated Up Cursor works until the cursor reaches the line where VEDIT must scroll down and write a new top line for each incoming Up Cursor. If Up Cur-

SEE OUR AD ON FACING PAGE

sor consists of the sequence ESC A, the Escapes can get lost, and one or several As may appear in your text. VEDIT's author, Ted Green, tells me that this problem is at its worst on the Heath H-19 terminal—the Repeat just sends too fast. In the absence of an interrupt-driven input buffer routine, the only remedy is a light touch on the Repeat button.

You can't enter control characters or reverse-video text into VEDIT's text buffer while in visual mode, presumably because any control character is a potential special function key. You can, however, switch to command mode, insert, say, your CTRL-L form feed, switch back to visual mode, and there it is, represented by the usual ^L.

Unfortunately, VEDIT doesn't provide a means for sending text to a printer. The only way you can print current text is to exit and use some other program. I find this annoying, but it hasn't caused me to take my command editors out of retirement.

Conclusions

VEDIT is a convenient, friendly, full-screen editor available at a reasonable price. It has several features specifically designed for program preparation and, for that purpose, has distinct advantages over command editors. It's readily adaptable to a wide variety of terminals and takes advantage of smart-terminal features. Special function keys can be assigned whatever functions you wish. If you don't have special function keys, substitute control characters and escape sequences of you own choice. The well-documented customization process is easily accomplished.

In addition to its screen mode, VEDIT has an adequate command mode. The command mode is useful in setting up string searches and substitutions; it also allows iteration macro commands that include transfers into visual mode and back. You won't spend much time in command mode. As part of a word-processing system, VEDIT has several limitations. You can't underline or even insert control characters in visual mode, and you can't send text to a printer. ■

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Add a Cassette Interface to Your VIC-20

William R. Hale
3309 June St. NE
Albuquerque, NM 87111

During the time I've owned a Commodore VIC-20, I've found it to be an excellent home computer. You really get a lot for your money. With so many excellent peripherals being introducted recently, the VIC-20 will be a great addition to the home computer market. I do feel, however, that the price (almost $100) Commodore is asking for a cassette recorder is a little high. Thus, I decided to design my own interface.

Figure 1 (on page 274) is a schematic of an interface that allows use of an ordinary, portable audio-cassette recorder to store programs from a VIC-20. The cost of the few parts needed, including a plastic case, runs about $10; the parts are available at Radio Shack and other electronic parts stores. The audio tape needed to store programs need not be of high quality due to the tones the VIC-20 uses. The cassette "shell" itself should not be so cheap that it causes the tape to drag.

Most of the components I used were already in my home stock, including the 6-pin connector to the VIC-20 motherboard. (See figure 1 for part numbers.) The VIC-20 outputs 0 to +4 volts (V) and prefers as an input a signal of an amplitude between 0 and −4 V. (Later testing has shown that the VIC-20 will accept a 0- to +4 V input if the signal consists of true square waves and does indeed range from 0 to +4 V.) Capacitor C1 allows the recorder to receive a normal AC input; the combination of C2 and CR1 allows DC restoration for the VIC-20 input. R2 is merely a fuse to protect the VIC-20.

L1 is an LED used to indicate that data is coming into the interface and is of sufficient level to properly operate IC1, which is being used as a wave-shaping circuit. L1 isn't a necessary part of the interface, but since the SN7404 has extra inverters, you might as well use one for the indicator. Switch S1 is also unnecessary because you can tie the line coming to it low. However, if you do this, be sure your recorder is in PLAY for the load and verify operations and in RECORD for any save operations before pressing the return key. Switch S2 is needed to rewind the tape. Always return this switch to REMOTE immediately after using it in MANUAL.

My particular recorder, Superscope Model C-76, uses +6.7 V to drive its motor, so I was able to use the VIC-20's motor-power line directly. Figure 1 also illustrates an alternate method for controlling the recorder using the VIC-20's +6.7 V motor line as a control signal.

Notice that the shield on the AUX input of the recorder is not connected to the VIC-20 system ground. I found that if I tied this line to the VIC-20 ground, noise would appear on the external speaker output of the recorder while I was attempting to load a program from the recorder. This noise was of sufficient level to trigger the input of inverter IC1 prematurely and cause an error message to be generated by the VIC-20.■

Figure 1: *Interface between the VIC-20 and a standard cassette recorder. Although the VIC-20 outputs 0 to +4 V, it seems to prefer a 0 to −4-V input. Switch S1 could be eliminated (see text), but it's safer to include it. Alternate sources for the connector to the VIC-20 are listed; an alternate motor control circuit is also shown.*

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Print Speed: 120 CPS

83A — 136 column printer w/tractor
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Print Speed: 120 CPS

84A — 136 column printer w/tractor
Throughput @ 136 characters per line: 114 lines per minute
Print Speed: 200 CPS

Centronics & RS-232C interfaces standard on models 82A & 83A. 2K serial buffer board (RS-232) optional on all models. Centronics 8-bit parallel interface and Okigraph HI-RES Graphics standard on Model 84A.

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  TREC-2/TRS-80 to Epson/Okidata Printer
  RSC-1/RS-232 (male to male)

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Anadex-9501 W/2K buffer	$1295.00
Diablo-630R0	$2095.00
C.Itoh Starwriter 45	$1925.00
Texas Instruments-810	$1650.00

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Manufacturer	Model #	Price
Novation	CAT	$ 149.00
Novation	d-CAT	$ 160.00
Novation	Auto-Cat	$ 229.00
DC Hayes	Smart Modem	$ 245.00
DC Hayes	Micro Modem II (Apple)	$ 320.00
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Livermore	LIV-Star 20M	$ 149.00
UDS	UDS 103 LP	$ 185.00
UDS	UDS 202 LP	$ 245.00

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Manufacturer	Model #	Price
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Amdek	100-80	$ 169.00
Amdek	100G/12" Grn.	$ 149.00
Amdek	Color-1 13"	$ 375.00
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Sanyo	DM 5012/12" B&W	$ 270.00
Sanyo	DM 5112ex/12" Grn.	$ 290.00
Sanyo	DM C6013/13" Color	$ 450.00
Zenith	ZVM-121/12" Grn.	$ 115.00

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Lear Siegler	ADM-3A	Call for price
Lear Siegler	ADM-3A+	Call for price
Lear Siegler	ADM-31	Call for price
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Lear Siegler	ADM-42	Call for price
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Televideo	TVI 950C	$ 925.00
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Z80A-CPU	$ 8.95	8255AC5	$ 6.95
Z80A-CTC	$ 8.95	8257AC5	$15.00
Z80A-DART	$13.95		

Regulators

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Connectors

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BYTE Printer Directory

Curtis P. Feigel
Technical Editor

To say that the printer market has blossomed is to make an apt analogy. An immense crop of printers with exciting features has flourished in the last few years. Unfortunately, a handful of thorns is waiting for those who make a hasty grab without carefully examining the field. Only an understanding of the present state of the art and knowledge of the printers available will help the personal-computer user choose the best printer for an application.

The printer provides an important and common man-machine interface. Recent advances in printer technology allow the use of personal computers in many new ways: producing letters, checks, and even pictures. However, a printer still represents a large investment to most people—sometimes as much as the rest of the computer system. BYTE provides this list of printers and their features to help you get the necessary information.

The newest printers offer standard features that illustrate the progressive thinking of designers and manufacturers, at a low cost that would have been impossible two years ago. Through the use of dedicated microprocessors, new printers provide bidirectional printing, short-line seeking, and multiple-font capability—features that are difficult to implement with mechanical printers. The presence (or absence) of these features is the key to selection of the proper printer.

Understanding Printers

Although a variety of printing technologies is available, the traditional *impact* printer is still the most common. The other printing concepts find favor in special applications (e.g., if copy must be produced at high speed, an ink-jet system might be used) where special attributes are used to advantage. The following is a description of the printing technologies you will discover in the microcomputer printer market:

Impact: Uses a type element with a raised character that strikes an inked ribbon against the paper, thus transferring the outline of the character to the paper. This is the same concept used in the common typewriter, but manufacturers have added several twists to the idea. In *daisy-wheel* or *thimble-type* printers, the complete set of type elements can be removed and replaced as a single unit. This makes it possible to change type fonts (the style of the letters) or install characters not commonly available.

The typical small-computer owner usually opts for an impact printer that uses a *dot-matrix* type element. This device prints characters made from dots in a closely spaced grid. It is popular because of its flexibility. In many units, the characters' form is stored in memory and can be changed easily. The presence or absence of dots can be controlled by the computer (in some fashion) so that graphs and pictures can be printed.

A rather unusual printer that might be classed with impact types uses a stylus to form the characters (an idea analogous to having a machine that draws with a pencil). The theory is that this system should provide the flexibility of a dot-matrix design with the fully formed characters of a daisy-wheel-type printer.

Thermal and Electrostatic: Both use a form of the dot-matrix print head, but depend on special paper to create the image, rather than ink from a ribbon. These printers are usually small, allow only 20 or 40 characters on a line, and have few extra features

Surprising Symmetries in Design and Letterforms . . .



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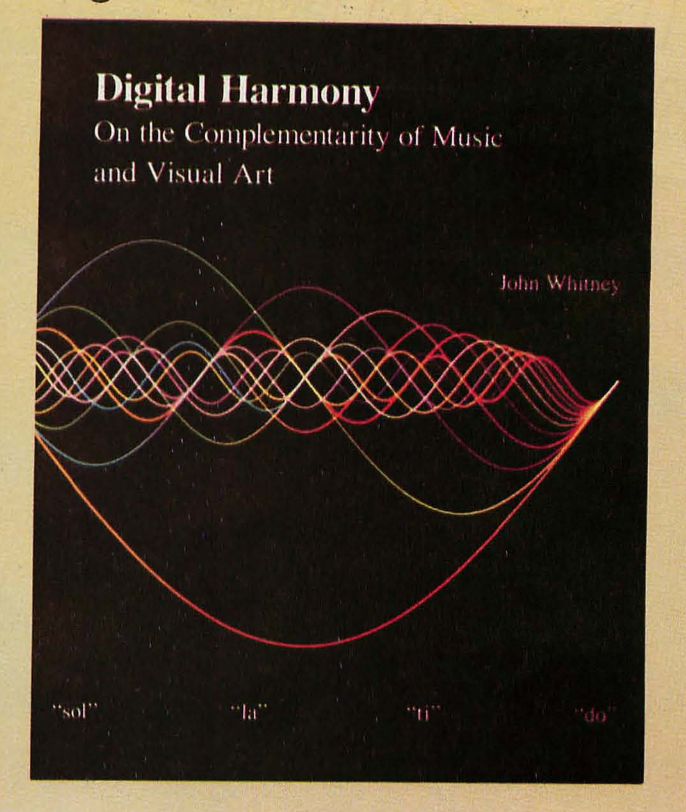
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because of their low cost. They are most popular in calculator-sized computer systems where space is at a premium.

Ink-Jet: This is actually a controlled spray of ink directly onto paper. Small droplets of ink formed at a nozzle are directed by electrostatic fields to cover the proper areas on the paper. This is a fast way to print whole pages because the inertia of the droplets is far smaller than that of mechanical systems. The system is flexible because the form of each character is computer-controlled.

Laser: Uses a raster-scan system similar in idea to a video display. The laser moves across a sensitized drum, "burning" a row of dots; as each row is completed, the beam moves down to begin the next row. The image is then transferred to paper, just as in a photocopier. Obviously, laser printers contain precision optical and mechanical parts, so they cost tens of thousands of dollars; but they are very flexible and fast.

Because many of these systems are relatively new, manufacturers have not been able to bring down their cost. Because of this money factor, we will mainly consider the impact, electrostatic, and thermal types. Even the least expensive of today's impact printers has features that set it apart from the teletypewriter that was the common hard-copy appliance 10 years ago. Here is an explanation of the concepts behind these features:

Print Quality: An obvious consideration for most people and small businesses. The quality of the characters that appear on paper is mostly determined by the printer technology used. Daisy-wheel and thimble-type printers produce *fully formed* characters that look similar to those produced by typewriters or typesetting equipment. Dot-matrix printers, although usually faster, are not as a rule capable of producing high-quality printing (the exception is multipass types that allow their dots to overlap, giving a fully formed look). In dot-matrix printers, the number of dots in the matrix is a good guide to the visual quality of the printing (i.e., a 9- by 14-dot character will probably look far better than a 5- by 7-dot one).

Character Sets: They can be an overriding factor if special characters are required. Although the type elements of daisy-wheel and thimble-type printers can be changed manually, many dot-matrix printers can be *programmed* with alternate character sets; some come with several preprogrammed sets. Almost all printers follow the ASCII (American Standard Code for Information Interchange) convention that assigns each standard character with a 7-bit binary number. Few printers, however, allow all 128 ASCII characters.

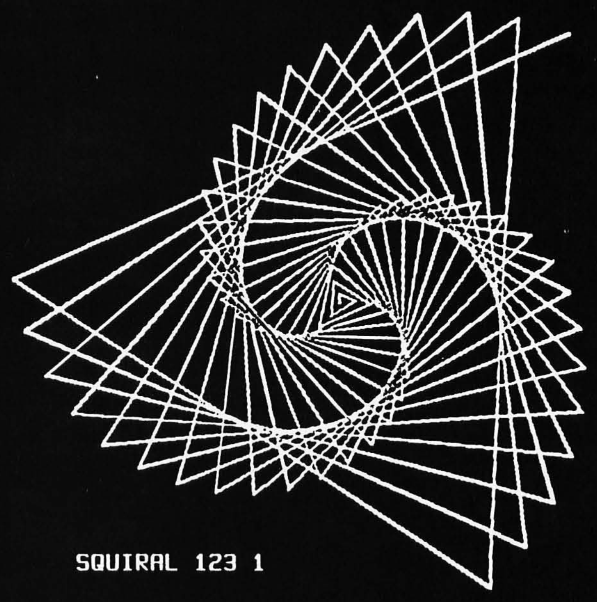
A related concern is the *font*, or style of type, used by the printer. This governs whether parts of the lowercase letters g, j, p, q, and y actually descend below the print line, whether the vertical lines of the characters are slanted, and whether or not the characters have serifs (short lines that extend at an angle from the ends of the main strokes of the letter). Many dot-matrix printers provide a feature to condense or expand the characters horizontally; some even slant or rotate the characters.

Although most printers produce characters that all take the same amount of space, an important feature on high-quality units is proportional spacing. (Perhaps you have noticed that typesetting—such as is used in magazines, newspapers, and books—produces characters that have a variety of widths.) This contributes much to the look of a printed page.

Speed: Many printers include features that allow them to print characters at a high rate. This may be as simple as a character set that is draft-quality (the printer doesn't spend much time making the character look pretty).

The Logo Language is Here
for the Apple II

```
TO SQUIRAL :ANGLE :DISTANCE
 IF :DISTANCE > 200 THEN STOP
 FORWARD :DISTANCE
 RIGHT :ANGLE
 SQUIRAL :ANGLE :DISTANCE + 3
END
```



SQUIRAL 123 1

Terrapin, the Turtle Company, brings you the Terrapin Logo Language for the Apple II with Turtle graphics, now ready for immediate delivery.

The Terrapin Logo language is a sophisticated and powerful language that is easy for anyone to use. Although originally intended for children, the Logo language is one that the most advanced programmers will enjoy using too. It includes many features common to artificial intelligence research languages permitting programs of great power to be written quickly and easily. Writing comparable programs in other languages is usually much more difficult and time consuming.

The Turtle graphics is fun and easy. With simple commands such as FORWARD, RIGHT, and PENUP you can draw in six hi-res colors. In just a few short sessions you can learn to create figures more complex than the one above whether you know how to program or not.

But the Terrapin Logo language is more than just a graphics language. It supports:

- list structure, allowing easy manipulation of words (strings) and lists
- user defined procedures which can be used exactly as if they were part of the language.
- fully integrated screen editor for procedures and text
- floating point and integer arithmetic
- a total of 120 primitives (commands) including 30 graphics commands
- recursion
- assembly-language interface capability

The Terrapin Logo language was developed by the Artificial Intelligence lab at the Massachusetts Institute of Technology. Terrapin is now authorized by MIT to distribute the results of its 12 years of research to you. To provide quality support for the language, Terrapin has assembled a team that includes two of the three authors who developed the Logo language for the Apple II at MIT, as well as Dr. Feurzeig, the originator of the Logo language.

Every copy of the Terrapin Logo language comes with complete documentation. To run the language, a 48K Apple II with a 16K RAM card or a language card, and one disk drive is required.

Terrapin also offers the robot Turtle, and the following books: *Turtle Geometry, Special Technology for Special Children, Mindstorms, Katie & the Computer,* and *Apple Logo* from Byte Books.

Suggested retail price: $149.95
To order or for more information, call or write:



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678 Massachusetts Avenue
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(617) 492-8816

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However, two logical concepts are important to the speed of any printer: bidirectional printing and short-line seeking. A printer that does bidirectional printing does not waste time moving the print head from the end of one line, at the right of a page, to the beginning of the next line at the left. It simply prints the next line backward, beginning at the right. A short-line-seeking printer skips over multiple spaces at a higher than normal speed and slows when the print head is located at the first printable character.

Forms: Paper that the printer will accept is usually limited to one or two types. A large amount of computer printouts are done on *fanfold* paper. However, *cut sheets* are preferred for correspondence and reports. Some printers accept only roll paper, as used on adding machines. *Forms controls* that allow the printer to automatically find the top of the next fanfold page, and feeding mechanisms that load the printer with a single sheet of paper, are also available.

(Fanfold continuous paper is separated into sheets by perforations along the top and bottom of each "page." A series of holes is provided along each margin for a *tractor* to move the paper vertically through the printer. Fanfold paper is available in a variety of styles and widths, including preprinted forms such as invoices and checks.)

Following is a listing of printer manufacturers and their products. Where possible, the information has been taken directly from the maker's literature. But please remember this caveat: a manufacturer may emphasize one feature and neglect to mention other features. Although we have made every attempt to keep the specifications accurate and up-to-date, errors do occur. Also, keep in mind that manufacturers reserve the right to alter specifications without notice.

A D Data Systems Inc.
200 Commerce Dr.
Rochester, NY 14623
(716) 334-9649

Addmaster Corporation
416 Junipero Serra Dr.
San Gabriel, CA 91776
(213) 285-1121
170: impact, 5 by 7 dot matrix; 18 or 21 char/line; 50 cps; 6 line/inch; ASCII or Baudot characters; time-of-day clock with battery backup; self test; friction feed; 2.25 inch wide roll paper; RS-232, 63 char buffer; Centronics or Apple II parallel; 8.25 by 12 by 5; 7 lbs; $299
180: impact, 5 by 7 dot matrix (9 by 7 optional); 34 or 40 char/line; 48 cps; 6 line/inch; ASCII or Baudot characters; time-of-day clock with battery backup; self test; friction or tractor feed; 4.5 inch wide roll paper or labels; RS-232, 40 char buffer; Centronics parallel; $399

Alphacom Inc.
3031 Tisch Way
San Jose, CA 95128
Sprinter 20: thermal, 5 by 8 dot matrix; 20 char/line; 96 char ASCII; graphics; rotated printing; roll paper; RS-232, 110 to 9600 bps; parallel; $175
Sprinter 40: thermal, 5 by 8 dot matrix; 40 char/line; 96 char ASCII; graphics; rotated printing; roll, fanfold paper; RS-232, 110 to 9600 bps; parallel; $350

Alps Electric Inc.
100 North Center Ave.
Rockville Center, NY 11570
(516) 766-3636
1200: stylus; 15, 18, 24, or 36 char/line; 6 cps; four colored ballpoint pens; graphics; all characters created under software control of the host computer; friction feed; 2.25 inch wide roll paper; 8.5 by 5.9 by 1.25; 1.1 lbs; $450
1100: same as 1200 except: one color only; $325

Amperex Electronics Corporation
230 Duffy Ave.
Hicksville, NY 11802
GP300: impact, 9 by 9 dot matrix; 120 or 144 char/line; 80 or 300 cps; vertical tab; paper out indicator; graphics; self test; two character sets; friction feed and tractor feed; sheet or fanfold paper; RS-232, 300 to 9600 bps; parallel; 20.5 by 17.5 by 7.4; 44 lbs; $3165

Anacom General Corporation
Computer Products Division
1116 Vallencia Dr.
Fullerton, CA 92631
(714) 992-0223
150: impact, 9 by 9 dot matrix; 136 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; lowercase descenders; double-width characters; bidirectional printing; short-line seeking; self test; graphics optional; paper-out indicator; top-of-form control; tractor feed adjustable to 15 inches wide; fanfold paper; RS-232, buffer optional; parallel; 34 lbs; $1495
150Z: impact, dot matrix; 40 or 220 char/line; 180 cps; four selectable char sets; graphics; tractor feed; fanfold paper; RS-232; parallel; $1650
160: impact, 9 by 9 dot matrix; 80 char/line; 150 cps; 6 or 8 line/inch; 94 char ASCII; graphics; lowercase descenders; paper-out indicator; top-of-form control; tractor feed adjustable to 10 inches wide; fanfold paper; RS-232 with handshaking, 110 to 9600 bps; 256 char buffer (1K to 4K char buffer optional); parallel; 17.5 by 18.5 by 7.9; 34 lbs; $1450
160Z: same as 160 except: 96 char ASCII, 2 pass high-quality mode; preprogrammed and programmable character sets; 70 by 70 dot graphics; self test; 4K char buffer

Anadex Inc.
9825 De Soto Ave.
Chatsworth, CA 91311
(213) 998-8010
DP8000: impact, 9 by 7 dot matrix; 80 char/line; 112 cps; 6 line/inch; 96 char ASCII; bidirectional printing; vertical tabs; double-width chars; paper-out indicator; self test; tractor feed; fanfold paper; RS-232, 110 to 9600 bps, 2 K char buffer; parallel; 18.6 by 14.2 by 7.3; 27 lbs; user-replaceable print head; $1125
DP8000 AP: same as DP8000 except: 96 char/line; 134 cps; Apple parallel interface
DP9000: impact, 9 by 9 dot matrix; 80 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; bidirectional printing; graphics, 72 by 60; compressed characters give 106 char/line at 200 cps; self test; tractor feed; fanfold paper; RS-232; Centronics parallel; 22 by 15.4 by 8.3; 30 lbs; $1550
DP9001: impact, 9 by 9 dot matrix; 80 char/line; 120 cps; 96 char ASCII; compressed characters give 132 char/line at 200 cps; tractor feed; fanfold paper; RS-232; Centronics parallel; $1550
DP9500: impact, 9 by 9 dot matrix; 80 or 132 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; lowercase descenders; underlining; double-width characters; condensed characters; bidirectional printing; short-line seeking; graphics; top-of-form control; self test; tractor feed adjustable to 15.6 inches wide; fanfold paper; RS-232, 800 char buffer; Centronics parallel; 35 lbs; $1650
DP9501: impact, 11 by 9 dot matrix; 80 or 132 char/line; 120 cps; 96 char ASCII; 6 or 8 line/inch; lowercase descenders; double-width characters; compressed characters give 176 char/line at 200 cps; underlining; graphics; bidirectional printing; short-line seeking; paper-out indicator; self test; tractor feed adjustable to 15.6 inches wide; fanfold paper; top-of-form control;

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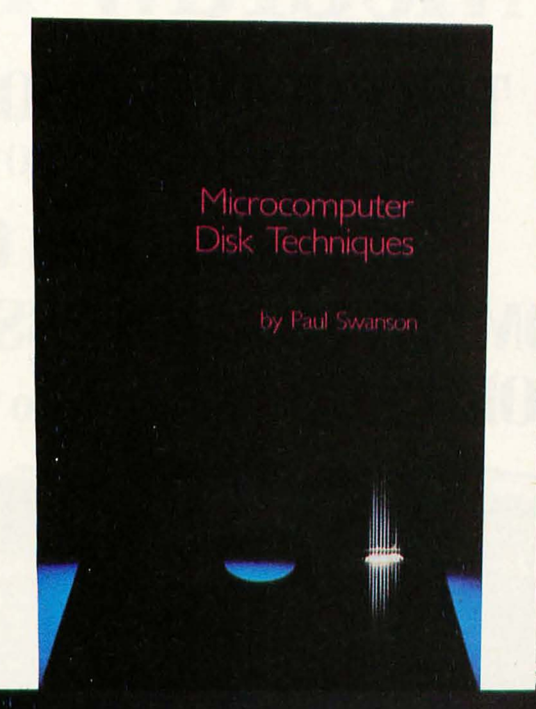
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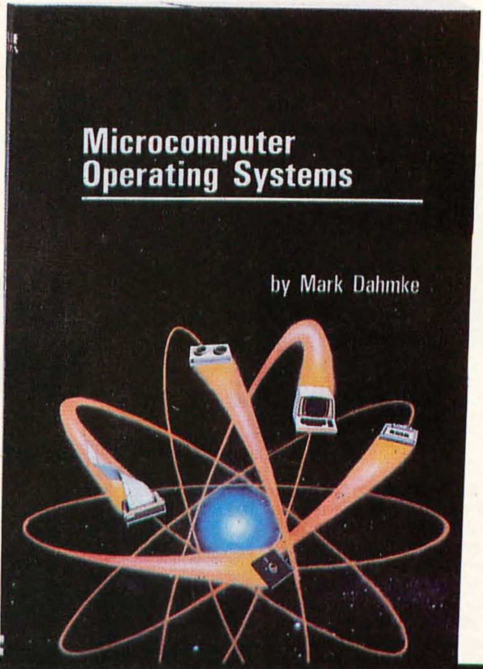
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Astronautics Corporation of America
POB 523
Milwaukee, WI 53201
(414) 671-5500
Autek Systems Corporation
3200 Coronado Dr.
Santa Clara, CA 95051
(408) 496-0400
Axiom Corporation
5932 San Fernando Rd.
Glendale, CA 91202
(213) 245-9244
GP-80M: impact, 5 by 7 dot matrix formed by single hammer; 80 char/line; 30 cps; 6 line/inch; 96 char ASCII; graphics; double-width characters; tractor feed adjustable to 9.5 inches wide; fanfold paper; RS-232; parallel; 13 by 6.75 by 5; 5 lbs; $399
EX-801 Micro Printer: electrostatic, 5 by 8 dot matrix; 20 or 80 char/line; 5 line/inch; 96 char ASCII; RS-232, 50 to 1200 bps, 256 char buffer; 11.75 by 12.75 by 4.4; 12 lbs; $599
EX-850 Video-Screen Printer: impact, dot matrix; 13 seconds/page; prints any screen image formed by dots; friction feed; sheet paper; $1595
IMP-1: impact, dot matrix; 80, 96, or 132 char/line; 100 cps; 96 char ASCII; graphics, 70 by 70 dots; friction feed; sheet paper; RS-232; parallel; $699
IMP-2: impact, dot matrix; 80, 96, or 132 char/line; 100 cps; 96 char ASCII; graphics; bidirectional printing; friction and tractor feed; sheet or fanfold; RS-232; Centronics parallel, Apple II, PET, and IEEE-488 interfaces
IMP-4: impact, 7 by 9 dot matrix; 80 char/line; 100 cps; 8 line/inch; 96 char ASCII; graphics, 19008 dot/inch; bidirectional printing; friction or tractor feed; sheet, fanfold, or roll paper; RS-232; Centronics parallel, Apple II, and IEEE-488 interfaces
Azurdata
4102 148th Ave. NE
Redmond, WA 98052
(206) 881-5100
40-Column Desktop: impact, 7 by 5 dot matrix; 40 char/line; 80 cps; 96 char ASCII; friction feed; 2.8 inch wide roll paper; RS-232, 1200 bps, 80 char buffer; 10 by 6.5 by 12.75; 11 lbs
40-Column Vehicle-Mounted: same as 40-Column Desktop except: 10.5 to 15 VDC; 0.1 A (standby), 4 A (printing); 6 by 12 by 13.5; 7 lbs
80-Column Desktop: impact, 9 by 9 dot matrix; 80 char/line; 57 cps; 96 char ASCII; double-width characters; bold characters; bidirectional printing; tractor feed adjustable to 10 inches wide; fanfold paper; RS-232, 9600 bps, 80 char buffer; 14.75 by 4.25 by 12; 12 lbs
Base 2
POB 3548
Fullerton, CA 92634
(714) 533-0111
800MST: impact, dot matrix; 80 or 132 char/line; 100 cps; 96 char ASCII; graphics; friction or tractor feed; RS-232, buffer; Centronics parallel
850: impact, 5 by 7 dot matrix; 80 or 132 char/line; 100 cps; 6 line/inch; 96 char ASCII; short-line seeking; bidirectional printing; vertical tabs; graphics; self test; friction and tractor feed; fanfold or roll paper; RS-232, 75 to 9600 bps, 2K char buffer; Centronics parallel; 15 by 11 by 3; 15 lbs; $799
BDS Computer Corporation
1120 Crane St.
Menlo Park, CA 94025
(415) 325-2115
Canon USA Inc. —Components
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Lake Success, NY 11040
(516) 488-6700
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Webb City, MO 64870
(417) 673-4631
2170: impact, 9 by 9 dot matrix; 132 char/line; 100 cps; 96 char ASCII; draft- and high-quality fonts; double-width, tall, boldface, and combination characters; bidirectional printing; short-line seeking; self test; upside-down printing; dual friction or dual tractor drives allow printer to be loaded with two types of forms; fanfold paper; RS-232; Centronics parallel; 20 by 20 by 7; 70 lbs
Centronics Data Computer Corporation
1 Wall St.
Hudson, NH 03051
(603) 883-0111
150: impact, 7 by 9 dot matrix; 80 char/line; 150 cps; 96 char ASCII; "international" character set optional; bidirectional printing; short-line seeking; top-of-form control; friction or tractor feed; sheet, fanfold, or roll paper to 10 inches wide; Centronics parallel; 14.9 by 13.8 by 5.9; 22 lbs
352: impact, 7 by 8 dot matrix; 132 char/line; 200 cps; 6 or 8 line/inch; 96 char ASCII; alternate character sets optional; bidirectional printing; short-line seeking; vertical tabs; graphics; programmable forms control; friction or tractor feed; sheet, fanfold, or roll paper; RS-232, 50 to 19200 bps, 2K char buffer; Centronics parallel; 22 by 18 by 8; 40 lbs
353: same as 352 except: also has high-quality printing mode at 50 cps
700: impact, dot matrix; 132 char/line; 69 cps; 64 char ASCII (96 char ASCII optional); friction and tractor feed; sheet or fanfold paper; Centronics parallel; $1460
701: impact, dot matrix; 132 char/line; 60 cps; 64 char ASCII (96 char ASCII optional); bidirectional printing; friction and tractor feed; sheet or fanfold paper; Centronics parallel; $1700
702: impact, 9 by 7 dot matrix; 132 char/line; 120 cps; 96 char ASCII; bidirectional printing; tractor feed; fanfold paper; Centronics parallel; $2660
703: same as 702 except: 180 cps; $2965
704: same as 702 except: 180 cps; RS-232; $1795
730: impact, 5 by 7 dot matrix; 80 char/line; 100 cps; 6 line/inch; 96 char ASCII; double-width characters; friction or tractor feed; sheet or fanfold paper to 9.5 inches wide; Centronics parallel; 11 lbs; $795
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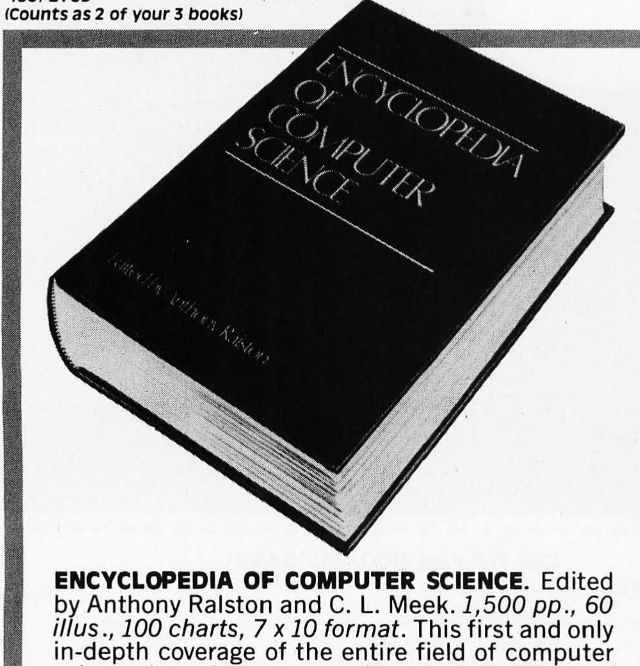
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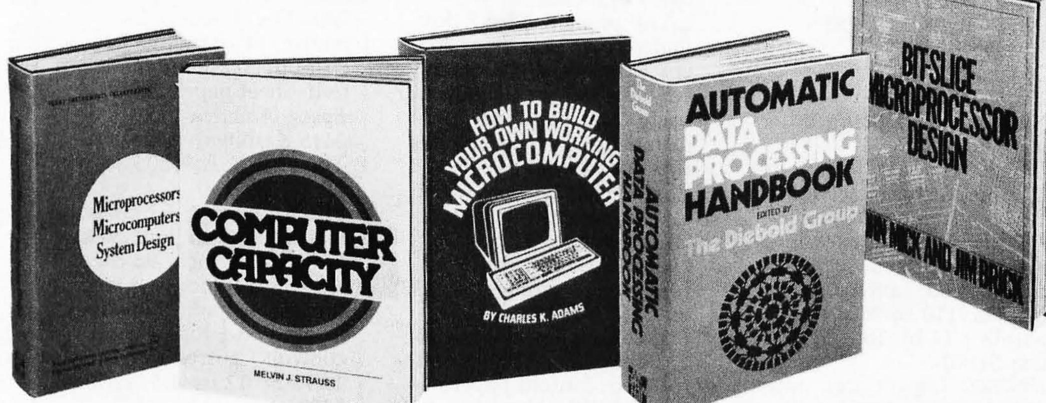
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H-25: impact, 9 by 9 dot matrix; 132 char/line; 150 cps; 6 or 8 line/inch; 96 char ASCII; graphics; bidirectional printing; self test; tractor feed adjustable to 17.75 inches wide; fanfold paper; RS-232, 110 to 9600 bps; 26.5 by 18.5 by 8.25; 80 lbs; $1095

Hecom Corporation
31-45 Park Rd.
Tinton Falls, NJ 07724
(201) 542-9200

Hewlett-Packard
1501 Page Mill Rd.
Palo Alto, CA 94304

Hi-G Company
580 Spring St.
Windsor Locks, CT 06096
(203) 623-3363
9/80: impact, 9 by 9 dot matrix; 80 char/line; 150 cps draft-quality, 75 cps high-quality; 96 char ASCII; bidirectional printing; short-line seeking; vertical tabs; graphics; top-of-form control; tractor or friction feed; sheet or fanfold paper; RS-232, 110 to 9600 bps, 350 char buffer, expandable to 3422 char; Centronics parallel; 21.25 by 16.5 by 7.25
9/132: same as 9/80 except: 132 char/line

Howard Industries
2031 East Cerritos Ave.
Anaheim, CA 92806
(714) 778-3443
Typrinter 221: impact, daisy wheel; 132 char/line; 20 cps; 100 char modified; ASCII; bidirectional printing; intelligent text editing; vertical tabs; paper-out indicator; self test; friction feed; sheet paper; RS-232; $2850

Informer Inc.
8332 Osage Ave.
Los Angeles, CA 90045
(213) 649-2030

Infoscribe
2720 South Croddy Way
Santa Ana, CA 92704
(714) 641-8595
500: impact, dot matrix; 136 char/line; 150 cps; 96 char ASCII (draft- and high-quality fonts); tractor feed; fanfold paper; RS-232; parallel; $1595
1000: impact, dot matrix; 136 char/line; 200 cps; 96 char ASCII (draft- and high-quality fonts); programmable character set; tractor feed; fanfold paper; RS-232; parallel; $1825
1500: impact, 9 by 9 dot matrix; 136 char/inch; 360 cps; 96 char ASCII; bidirectional printing; tractor feed adjustable to 16 inches wide; fanfold paper; RS-232, 110 to 9600 bps; parallel; $1895

Integral Data Systems (IDS)
Milford, NH 03055
(603) 673-9100
445: impact, dot matrix; 80 or 132 char/line; 198 cps; 96 char ASCII; graphics (optional); tractor feed; fanfold paper; parallel (RS-232 optional); $795
460: impact, dot matrix; 80 char/line; 150 cps; 96 char ASCII; bidirectional printing; auto justification; proportional spacing; graphics, 84 by 84 dots; $995
560: impact, dot matrix; 132 or 220 char/line; 198 cps; 96 char ASCII; bidirectional printing; single-dot graphics; tractor feed; fanfold paper; RS-232; parallel (optional); $1695
Prism: impact, 24 by 9 overlapping dot matrix; 200 cps draft mode, 150 cps high-quality; 96 char ASCII; double-width characters; bold characters; bidirectional printing; short-line seeking; color graphics; proportional spacing; friction or tractor feed; sheet or fanfold paper; RS-232, 300 to 9600 bps; Centronics parallel; 21.75 by 12.5 by 8.5; 29 lbs

Integrex Inc.
233 North Juniper
Philadelphia, PA 19107
(215) 627-0966
CX80 Colour: impact, 5 by 7 dot matrix; 80 char/line; 125 cps; 6 or 8 line/inch; 96 char ASCII; preprogrammed and programmable graphics characters; dot graphics; prints in up to seven colors using special ribbon; self test; tractor feed adjustable to 10 inches wide; fanfold paper; RS-232, 75 to 9600 bps; Centronics parallel; IEEE-488; Apple II; 16.25 by 12.8 by 7.5; 21 lbs

Innovative Electronics Inc.
15200 Northwest 60th Ave.
Miami Lakes, FL 33014
(305) 558-1591

Interface Mechanics Inc.
4405 Russell Rd.
Lynnwood, WA 98036
(206) 743-7036

C. Itoh Electronics Inc.
5301 Beethoven St.
Los Angeles, CA 90066
(212) 682-0420
Comet I: impact, dot matrix; 80 char/line; 125 cps; 96 char ASCII; bidirectional printing; tractor feed; fanfold paper; RS-232, 2K char buffer; parallel; $455
Comet II: impact, dot matrix; 136 char/line; 125 cps; 96 char ASCII; bidirectional printing; tractor feed; fanfold paper; RS-232, 2K char buffer; parallel; $1290
Star Writer I: impact, daisy wheel; 132 char/line; 25 cps; friction or tractor feed; sheet or fanfold paper; RS-232; parallel; $2380
Star Writer II: impact, daisy wheel; 132 char/line; 45 cps; friction or tractor feed; sheet or fanfold paper; RS-232; parallel; $2898

Ivo Industries Inc.
1109 Green Grove Rd.
Neptune, NJ 07757
(201) 922-3600

Landis and Gyr Inc.
Industrial Products

4 Washington Plaza
Elmsfield, NY 10523
(914) 592-4400
Lear-Siegler Inc.
714 North Brookhurst St.
Anaheim, CA 92803
310 Ballistic: impact, 7 by 9 dot matrix; 136 char/line; 180 cps; 128 char ASCII; vertical tabs; compressed characters (optional); programmable forms control tractor feed; fanfold paper; RS-232, 70 to 9600 bps (2K char buffer optional); parallel; 27 by 19.8 by 8; 50 lbs; $2045
Litton Industries
Westrex OEM Products
1140 Bloomfield Ave.
West Caldwell, NJ 07006
(201) 227-7290
Mag Labs Inc.
1 Crown Dr.
Apalachin, NY 13732
(607) 625-2161
Malibu Electronics Corporation
2301 Townsgate Rd.
Westlake Village, CA 91361
(805) 496-1990
165: impact, 10 by 9 dot matrix; 165 cps; graphics; RS-232; parallel; $2295
200: impact, 9 by 18 dot matrix, double pass; 132 char/line; 250 cps; 6 or 8 line/inch; 96 char ASCII (multiple fonts); bidirectional printing; graphics, 120 by 144 pixels; self test; friction and tractor feed; sheet or fanfold paper; RS-232, 110 to 9600 bps; 23.9 by 17.1 by 7; 41 lbs; $2995
Mannesman-Talley
8024 South 180th St.
Kent, WA 98031
(206) 251-5524
MT-1800: impact, 7 by 9 dot matrix, double pass; 132 or 218 char/line; 200 cps; 6 or 8 line/inch; bidirectional printing; vertical tabs; double-width characters; compressed characters; paper-out indicator; self test; tractor feed; fanfold paper; RS-232, 300 to 9600 bps; parallel; 25.5 by 19.5 by 18.5; 63 lbs; $2495
Matchless Systems
18444 Broadway
Gardena, CA 90248
(213) 327-1010
MDS Trivex
3180 Redhill Ave.
Costa Mesa, CA 92626
(714) 546-7781
MPI (Micro Peripherals Inc.)
4426 South Century Dr.
Salt Lake City, UT 84107
(801) 263-3081
88G: impact, 11 by 7 dot matrix; 80 or 132 char/line; 100 cps; 6 or 8 line/inch; 96 char ASCII (draft- and high-quality fonts); bidirectional printing; graphics; friction or tractor feed; sheet, fanfold, or roll paper; RS-232, 1K char buffer; Centronics parallel; 16.3 by 10.8 by 6.3; 15 lbs; $749
Microtek Inc.
9514 Chesapeake Dr.
San Diego, CA 92123
Tekwriter-1 (formerly Bytewriter 1): impact, 7 by 7 dot matrix; 80 char/line; 80 cps; friction feed; sheet or roll paper; parallel Centronics, Apple II, or Atari; $349
Tekwriter-2: impact, 9 by 9 dot matrix; 80 or 132 char/line; graphics; Centronics parallel
MT-80: impact, dot matrix; 80 char/line; 125 cps; 96 char ASCII; tractor feed; fanfold paper; RS-232, 3K char buffer; parallel; $795
Miltope Corporation
9 Fairchild Ave.
Plainview, NY 11803
(516) 349-9500
Newman Computer Exchange Inc.
1250 North Main St.
Ann Arbor, MI 48104
(313) 994-3200
NEC Information Systems Inc.
5 Militia Dr.
Lexington, MA 02173
5510: impact, thimble; 132 char/line; 55 cps; 6 or 8 line/inch; 128 char ASCII (multiple fonts); bidirectional printing; vertical tabs; paper-out indicator; friction and tractor feed; sheet or fanfold paper; cut-sheet feeder; RS-232, 110 to 1200 bps, 256 char buffer; 25 by 16.5 by 8.7; 45.5 lbs; $3055
5520: impact, thimble; 132 char/line; 55 cps; 128 char ASCII (multiple fonts); friction or tractor feed; sheet or fanfold paper; cut-sheet feeder; RS-232, 110 to 1200 bps; $3415
5530: impact, thimble; 132 char/line; 55 cps; 128 char ASCII (multiple fonts); friction or tractor feed; sheet or fanfold paper; cut-sheet feeder; parallel; $3055
Okidata Corporation
111 Gaither Dr.
Mount Laurel, NJ 08054
(609) 235-2600
Microline 80: impact, dot matrix; 80 or 132 char/line; 80 cps; 96 char set; friction and tractor feed; sheet or fanfold paper; parallel; $475
Microline 82A: impact, 9 by 9 dot matrix; 80 or 132 char/inch; 120 cps; 6 or 8 line/inch; short-line seeking; bidirectional printing; graphics; double-width characters; compressed characters; friction and tractor feed; sheet or fanfold paper; RS-232, 110 to 1200 bps; parallel; 14.2 by 12.9 by 5.2; 20 lbs; $645
Microline 83: impact, dot matrix; 132 char/line; 120 cps; 96 char ASCII; bidirectional printing; tractor feed adjustable to 15 inches wide; fanfold paper; RS-232; parallel
SL300: impact, dot matrix whole-line printer; 132 char/line; 300 lpm; 96 char ASCII; software selectable fonts, oversized chars; barcode font; graphics; tractor feed; parallel; $3995
Olivetti Peripheral Equipment
505 White Plains Rd.
Tarrytown, NY 10591
(914) 631-3000
DY-211: impact, daisy wheel; 132 char/line; 20 cps; 5 or 6 line/inch; 96 char ASCII; manually changeable print element; friction feed accepts paper up to 17 inches wide; RS-232, 110 to 9600 bps; 36 lbs; $1900
DY-311: impact, daisy wheel; 150 char/line; 32 cps; 5 or 6 line/inch; 96 char ASCII; bidirectional printing; manually changeable print element; friction or tractor feed; sheet or fanfold paper; RS-232, 100 to 9600 bps; parallel; 39.5 lbs; $2850
DY-811: impact, daisy wheel; 150 char/line; 65 cps; 5 or 6 line/inch; 96 char ASCII; bidirectional printing; manually changeable print element; friction or tractor feed; sheet or fanfold paper; RS-232, 110 to 9600 bps; parallel; 79 lbs; $4280
DM80/180: impact, 8 by 7 dot matrix; 150 char/line; 80 cps; 5 or 6 line/inch; 96 char ASCII; bidirectional printing; friction or tractor feed; sheet or fanfold paper; RS-232, 110 to 9600 bps; parallel; 79 lbs; $4280
Pertec Computer Company
12910 Culver Blvd.
Los Angeles, CA 90066
Stylist 360: impact, daisy wheel; 198 char/line; 17 cps; 100 char modified ASCII; bidirectional printing; friction feed; sheet or fanfold paper; RS-232; parallel; 20.9 by 13 by 5.5; 29 lbs; $1500
Printek Inc.
1517 Townline Rd.
Benton Harbor, MI 49022
(616) 925-3200
910: impact, 9 by 9 dot matrix; 80 char/line; 170 cps; 96 char ASCII, programmable character set; double-width characters; bidirectional printing; tractor feed; fanfold paper; RS-232, 1800 char buffer; parallel; 23 by 17 by 7; $1695
920: same as 910 except: 340 cps; $2345
Printer Terminal Communications Corporation
124 10th St.
Ramona, CA 92065
879: impact, 7 by 9 dot matrix; 80 or 132 char/line; 180 cps; 6 line/inch; 96 char ASCII; bidirectional printing; vertical tabs; compressed characters; friction and tractor feed; sheet, fanfold, or roll paper; RS-232, 300 to 9600 bps, 256 char buffer; parallel; 18 by 22 by 7.5; 25 lbs; $1299
Printronix
17421 Derian Ave.
Irvine, CA 92713
(714) 549-8272
Qantex
60 Plant Ave.
Hauppage, NY
(516) 582-6060
Qume Corporation
2350 Qume Dr.
San Jose, CA 95131
(408) 942-4000
Sprint 5/45: impact, daisy wheel; 132 char/line; 45 cps; friction or tractor feed; sheet or fanfold paper; cut-sheet feeder; RS-232; parallel; $3137
Sprint 5/55: impact, daisy wheel; 132 char/line; 55 cps; 3 to 8 line/inch; manually changeable print element; bidirectional printing; vertical tabs; graphics; paper-out indicator; self test; friction feed; sheet paper; RS-232, 110 to 9600 bps; 24.3 by 16.8 by 6.5; 45 lbs; $3726
Sprint 9/35: impact, daisy wheel; 132 char/line; 35 cps; manually changeable print element; friction or tractor feed; sheet or fanfold paper; RS-232; parallel
Sprint 9/45: same as 9/35 except: 45 cps
Sprint 9/55: same as 9/35 except: 55 cps
Sprint Wide-Track: impact, daisy wheel; 240 char/line; 55 cps; manually changeable

print element; friction feed; sheet paper; RS-232; parallel; $4315

Radio Shack
1 Tandy Center
Fort Worth, TX 76102
Daisywheel II: impact, daisy wheel; 136 char/line; 43 cps; manually changeable print element; proportional spacing; friction feed; sheet paper; Centronics parallel; $1860
Lineprinter IV: impact, dot matrix; 80 or 132 char/line; 50 cps; 96 char ASCII; friction or tractor feed; sheet or fanfold paper; Centronics parallel; $999
Lineprinter V: impact, dot matrix; 132 char/line; 120 cps; 96 char ASCII; tractor feed; fanfold paper; Centronics parallel; $1860
Lineprinter VI: impact, dot matrix; 132 char/line; 100 cps; 96 char ASCII plus graphics characters; bidirectional printing; self test; Centronics parallel; $1160
Lineprinter VII: impact, 5 by 7 dot matrix; 40 or 80 char/line; 30 cps; 6 line/inch; graphics; tractor feed; fanfold paper; RS-232, 100 to 600 bps; Centronics parallel; $399
Lineprinter VIII: impact, 9 by 12 dot matrix; 80 char/line; 80 cps; 8 or 12 line/inch; graphics; bidirectional printing; short-line seeking; proportional spacing; friction or tractor feed; sheet, fanfold, or roll paper; self test; RS-232, 600 or 1200 bps; Centronics parallel; 15.4 by 11 by 4.7; 16.5 lbs; $799
Quick Printer II: electrostatic, dot matrix; 16 char/line; 32 cps; uppercase only; compressed characters give 32 char/line at 64 cps; friction feed; aluminized roll paper 2.4 inches wide; $219

Sanders Technology
Columbia Drive
Amherst, NH 03061
(603) 882-1000
Media 12/7: impact, line-wide dot matrix, overlapping passes; 80 char/line; 96 char ASCII (draft- and high-quality); 220 cps draft-quality, 60 cps high-quality; preprogrammed alternate fonts; proportional spacing on some fonts; high-quality compressed-character font gives 117 char/line at 120 cps (proportional spacing); friction feed; sheet paper; cut-sheet feeder; RS-232, 2400 bps with handshaking; Centronics parallel; $4395

Sci Systems Inc.
8600 South Memorial Parkway
Huntsville, AL 35802
(205) 881-1611

Sentinel Computer Corporation
9902 Carver Rd.
Cincinnati, OH 45242
(513) 984-6622

Siemens Corporation
OEM Data Products Division
240 East Palais
Anaheim, CA 92805
(714) 991-9700

Smith-Corona
65 Locust Ave.
New Canaan, CT 06840
(203) 972-1471
TP-1: impact, daisy wheel; 105 or 125 char/line; 12 cps; manually changeable print element; friction feed; sheet paper; $845

Star Micronics Inc.
200 Park Ave.
New York, NY 10166
(212) 986-6770
DP-8480: impact, 7 by 9 dot matrix; 132 char/line; 80 cps; 96 char ASCII; short-line seeking; bidirectional printing; graphics; double-width characters; compressed characters; self test; friction and tractor feed; sheet or fanfold paper; RS-232, 256 char buffer; 15.3 by 12.2 by 4.9; 19 lbs; $495

Systemed Corporation
POB 18
Mountain City, TN 37683
(615) 727-6000
Typrinter: impact, daisy wheel; 180 char/line; 12 cps; manually changeable print element; friction feed; fanfold paper; parallel; $599

Syntest Corporation
169 Milham St.
Marlborough, MA 01752
(617) 481-7827

TDC
203 East Main St.
Riverton, WY 82501
(307) 856-7111

TEI Inc.
5075 South Loop East
Houston, TX 77033
(910) 881-3639
3431: impact, 9 by 9 dot matrix; 136 char/line; 150 cps; 6 or 8 line/inch; 94 char ASCII; bidirectional printing; double-width characters; paper-out indicator; self test; tractor feed; fanfold paper; RS-232, 110 to 9600 bps, 256 char buffer; parallel

Telecom Terminal Systems
3903 Grand View Blvd.
Los Angeles, CA 90066
(213) 390-9494

Teletype Corporation
5555 Touhy Ave.
Skokie, IL 60077
(312) 982-2000
43: impact, dot matrix; 80 or 132 char/line; 30 cps; 96 char ASCII; friction or tractor feed; RS-232; $1388

Texas Instruments
POB 225012
M/S 84
Dallas, TX 75265
(312) 982-2000
743: electrostatic, dot matrix; 80 char/line; 30 cps; 96 char ASCII; APL char set (optional); friction feed; aluminized roll paper; RS-232; $1995
765: electrostatic, dot matrix; 80 char/line; 30 cps; 96 char ASCII; bubble-memory storage up to 80K char; dual communications ports; friction feed; aluminized roll paper; RS-232 (integral modem optional); $2995
810: impact, 9 by 7 dot matrix; 132 char/line; 150 cps; 6 or 8 line/inch; 64 char modified ASCII (96 char ASCII optional); double-width characters (optional); compressed characters (optional); bidirectional printing; vertical tabs; paper-out indicator; self test; tractor feed; fanfold paper; RS-232, 110 to 9600 bps, 256 char buffer; $1895
820: impact, dot matrix; 132 char/line; 150 cps; 96 char ASCII; APL char set (optional); tractor feed; fanfold paper; RS-232, 110 to 9600 bps; $2165
825: impact, 9 by 7 dot matrix; 75 cps; 6 or 8 line/inch; bidirectional printing; RS-232, 110 to 600 bps, 256 char buffer; $1565

Toshiba America Inc.
2441 Michelle Dr.
Tustin, CA 92680
(714) 730-5000

Trendcom
480 Oakmead Parkway
Sunnyvale, CA 94086
(408) 737-0747
100: thermal, dot matrix; 40 char/line; 40 cps; 96 char ASCII; friction feed; sensitized roll paper; Centronics parallel, IEEE-488

United Systems Corporation
918 Woodley Rd.
POB 458
Dayton, OH 45401

Victor Business Products
3900 North Rockwell St.
Chicago, IL 60618

Vista
1317 East Edinger Ave.
Santa Ana, CA 92705
(714) 953-0523

Wang Laboratories
1 Industrial Ave.
Lowell, MA 01851
2231 W-1: impact, 7 by 9 dot matrix; 112 char/line; 120 cps; 96 char ASCII; vertical tabs; double-width characters; paper-out indicator; self test; Wang serial interface, 112 char buffer; 24 by 18 by 10; 60 lbs; $2900
2281W: impact, daisy wheel; 157 char/line; 30 cps; 6 line/inch; 96 char ASCII; bidirectional printing; vertical tabs; graphics; Wang serial interface; $4500

Wasomark Inc. (Data Printer Division)
1 Willard Rd.
Norwalk, CT 06856
(203) 847-7251

Williams Laboratories
125 Northview Rd.
Ithaca, NY 14850
(607) 272-1132
Bytewriter: impact, daisy wheel; 100 char/line; 12 cps; manually changeable print element; self test; underlining; friction feed; sheet paper; Centronics parallel; 21 lbs; $795

Xerox Corporation
Xerox Square
Rochester, NY 14644
(716) 423-3411
1730: impact, daisy wheel; 132 char/line; 40 cps; manually changeable print element; friction feed; sheet paper; RS-232; $2710
1740: impact, daisy wheel; 132 char/line; 45 cps; manually changeable print element; friction feed; sheet paper; RS-232; $3375
1750: impact, daisy wheel; 132 char/line; 45 cps; manually changeable print element; friction feed; sheet paper; RS-232; $3555

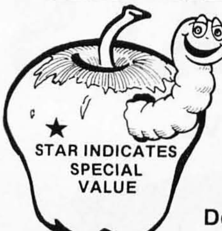
Xymec Inc.
17905 J Sky Park Circle
Irvine, CA 92714
(714) 423-3411
HY-Q 1000: impact, daisy wheel; 198 char/line; 20 cps; manually changeable print element; boldface characters; paper-out indicator; self test; RS-232; parallel

Zentec Corporation
2400 Walsh Ave.
Santa Clara, CA 95050
(408) 246-7662■

Computer Exchange

P.O. Box 1380, Jacksonville, OR 97530

929



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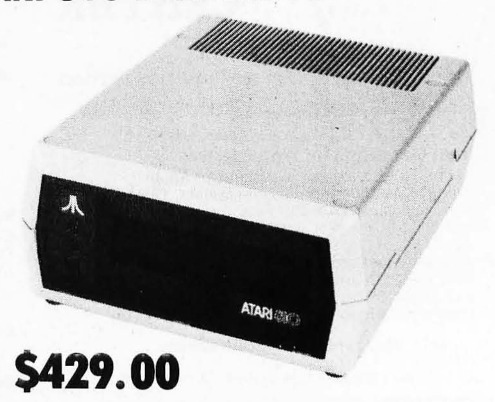
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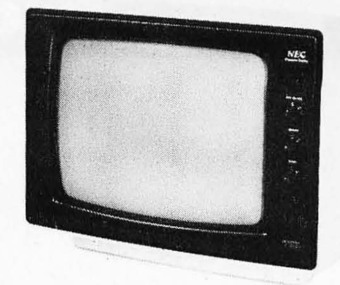
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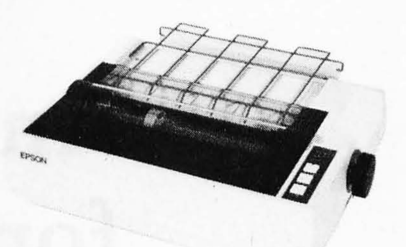
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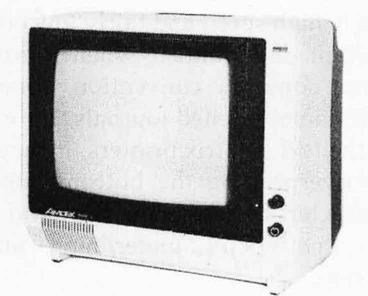
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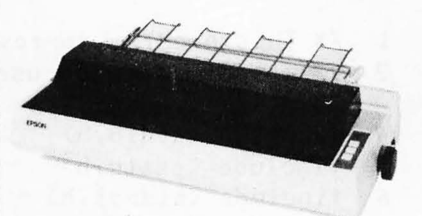
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An Underline Filter for Matrix Printers

Adam Reed
Center for Human Information Processing
UCSD C-009
La Jolla, CA 92093

Although matrix printers such as Digital Equipment Corporation's Decwriter III have the advantages of relatively high speed and fairly low cost, they do have an important disadvantage when it comes to printing manuscript copy. By convention, some items in manuscripts (the names of cited journals, for example) are underlined in the text. Matrix printers, if they underline at all, do so by overprinting the bottom line of each "underlined" character. Besides being slow and aesthetically unappealing, this type of "underlining" makes the text nearly illegible.

Fortunately, many matrix printers, including the Decwriter, can achieve half-line vertical spacing. The program in listing 1 sets this option, converts the underline characters to minus signs (which are the same length as underline characters on most matrix printers, including the Decwriter), then moves them onto a separate line to be printed under the corresponding line of text. The result is clear, fast, legible underlining. At the end of the text file, the program restores the Decwriter to normal vertical spacing.

The program in listing 1 is written in C to act as a "filter" under the Unix operating system. Its input is a text file with standard underlining, and its output is the input to the matrix printer. It can be translated readily into other languages, such as BASIC or FORTRAN, for use with other operating systems and matrix printers. ■

Listing 1.

```
/* This program improves Decwriter underline handling by using a line buffer */
/* and may also be used to change, temporarily, the dw3's horizontal pitch . */

#include <stdio.h>
#include <sgtty.h>
#include <signal.h>

int dwreset();

main(argc,argv) int argc; char *argv[];  {

        register char c, h, *p;
        int b, n;
```

Listing 1 continued on page 302

Listing 1 continued:

```
        char opstring[256] ;
        char *option = opstring ;
        char *pmax, *plast;
        static char buf[256];
        setbuf( stdout, (char *)malloc( BUFSIZ ));

                /* Make sure to reset decwriter if interrupted */

        signal(SIGHUP, dwreset);
        signal(SIGINT, dwreset);
        signal(SIGQUIT,dwreset);
        signal(SIGKILL,dwreset);
        signal(SIGPIPE,dwreset);
        signal(SIGALRM,dwreset);
        signal(SIGTERM,dwreset);

                /* Get the option from the command */

        strcat (option,argv[1]) ;
        if (*option == NULL) c = '2';
        else {
                c = *option++ ;
                if (c == '+' || c == '-') c = *option++ ;
                if (c == '1') c = *option++ ;
                if (c == 'p' || c == 'P') c = '0' ;
                if (c == 'n' || c == 'N') c = '6' ;
                if (c == 'w' || c == 'W') c = '8' ;
        }
                /* Then, initialize the Decwriter */

        putchar(27); printf("[3z");
        putchar(27); printf("[132t");
        putchar(27); printf("[1,132r");
        putchar(27);
        if            (c == '0'){printf("[1w");putchar(27);printf("[1;84s");}
                else if (c == '6'){printf("[4w");putchar(27);printf("[1;140s");}
                else if (c == '8'){printf("[8w");putchar(27);printf("[1;70s");}
                else              {printf("[2w");putchar(27);printf("[1;102s");}

                /* Then process the file: */

        c=getchar();
        while ( c != EOF ) {
                /* Main loop: process each line in turn: */


                h=b=0;
                plast=pmax= &buf[255];
                p=buf;
                while ( p<plast ) *p++ = 32;     /* clear under line buffer */
                plast=p=buf;
                while ( c!=10 && c!=EOF && c!= 13 && p<pmax )  {

                        /* loop for processing characters. */
```

Listing 1 continued on page 304

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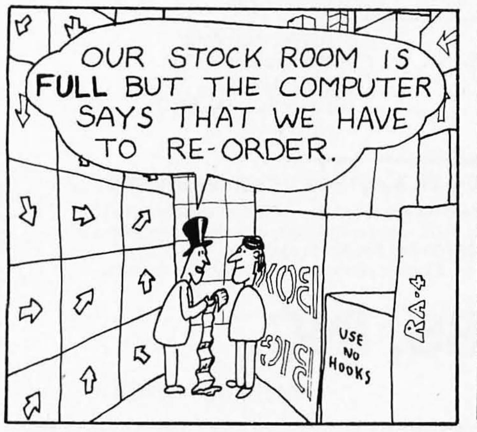
Circle 268 on inquiry card.

Listing 1 continued:

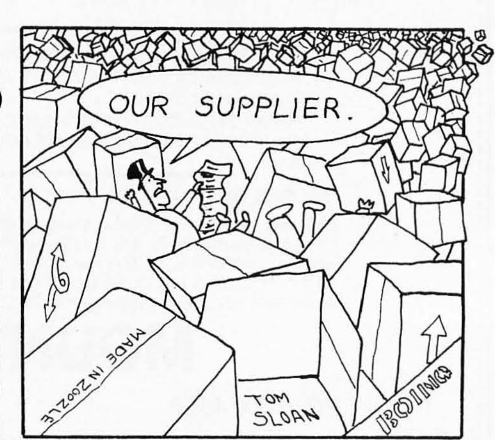
```
        if ( c== 3 ) dwreset(); /*  catch interrupt signals  */

        if ( c=='\t' ) {            /* tab both text and ul line */
                putchar ( '\t' ) ;
                *p++ = '\t' ;
                if (plast<p) plast=p;
        }
        else if ( c=='_' ) {       /* underline, backspace? */
                if ((c = getchar()) == '\b') {
                        b=2;
                }
                else {
                        *p++ = '-';
                        if (plast<p) plast=p;
                        putchar(32);
                        h=1;     /* a character is waiting */
                }
        }
        else if ( c=='\b' ) {      /* backspace, underline? */
                if ((c = getchar()) == '_') {
                        if (plast<p) plast=p;
                        *(p-1) = '-';
                }
                else {
                        h = 1 ;
                        putchar('\b');
                        --p;
                }
        }
        else {                  /* ordinary char */
                putchar(c);
                ++p;
                if ( b==2 ) {      /* previously underlined char */
                        b = 0 ;
                        if (plast<p) plast=p;
                        *(p-1) = '-';
                }
        }
        if ( h==1 ) h=0;           /* character read already */
```

Listing 1 continued on page 306







Circle 275 on inquiry card.

Listing 1 continued:

```
                        else c=getchar();
                }
                putchar (10);               /* go down to underline position */
                p=buf;
                while ( p<plast ) {         /* output and clear under line */
                        putchar(*p);
                        *p++ = 32;
                }
                plast=buf;
                putchar(10);
                if ( c!=10 && c!=13 ) break;      /* any c other than LF or CR */
                                            /* at end-of line indicates error */
                c=getchar();                /* otherwise get first c in new line */
        }                                   /* or EOF */

        /* after EOF the end is near, so reset decwriter to normal mode */

        alarm(120);
        dwreset();

}                                                 /* THE END */

dwreset() {                 /* Subroutine to reset the decwriter to normal mode */

        signal(SIGINT,SIG_IGN);
        putchar(27); printf("[1z");
        putchar(27); printf("[66t");
        putchar(27); printf("[1,66r");
        putchar(27); printf("[2w");
        putchar(27); printf("[1,102s");
        exit();

}
```

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SUPER SUB CHASE simulates a search and destroy mission. Set your course and keep an eye on the sonar readings as you hunt for the hidden submarine. Set the depth charge explosion depth and watch them sink towards the sub. This is an addictive game which takes advantage of the Atari's graphics and sound capabilities. One or two players. Joystick(s) required.

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This is an exciting graphical simulation of the problems involved in closely observing a black hole with a space probe. The object is to enter and maintain, for a prescribed time, an orbit close to a small black hole. This is to be achieved without coming so near the anomaly that the tidal stress destroys the probe. Control of the craft is realistically simulated using side jets for rotation and main thrusters for acceleration. This program employs Hi-Res graphics and is educational as well as challenging.

NEW **SPACE EVACUATION! (Apple, Atari and TRS-80 only)** — Price: $15.95 Cassette/$19.95 Diskette
Can you colonize the galaxy and evacuate the Earth before the sun explodes? Your computer becomes the ship's computer as you explore the universe to relocate millions of people. This simulation is particularly interesting as it combines many of the exciting elements of classic space games with the mystery challenge of ADVENTURE.

MONARCH (Atari only) — Price: $11.95 Cassette/$15.95 Diskette
MONARCH is a fascinating economic simulation requiring you to survive an 8-year term as your nation's leader. You determine the amount of acreage devoted to industrial and agricultural use, how much food to distribute to the populace and how much should be spent on pollution control. You will find that all decisions involve a compromise and that it is not easy to make everyone happy. Runs in 16K Atari.

CHOMPELO (Atari only) — Price: $11.95 Cassette/$15.95 Diskette
CHOMPELO is really two challenging games in one. One is similar to NIM; you must bite off part of a cookie, but avoid taking the poisoned portion. The other game is the popular board game REVERSI. It fully uses the Atari's graphics capability, and is hard to beat. This package will run on a 16K system.

SPACE LANES (Available for all computers) — Price: $10.95 Cassette/$14.95 Diskette
SPACE LANES is a simple but exciting space transportation game which involves up to four players (including the computer). The object is to form and expand space transportation companies in a competitive environment. The goal is to amass more net worth than your opponent. The economics include stock purchases and company mergers. Watch your wealth grow!

AVAILABILITY

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard (IBM 3740 single density/double density compatible format) 8" CP/M floppy disks for systems running under MBASIC (for example, Altos, Xerox 820 and many others). 5¼" CP/M diskettes are available for the North Star and Osborne computer systems.

**ATARI, PET/CBM, NORTH STAR, CP/M, IBM, OSBORNE and XEROX are registered tradenames and/or trade marks.*

***Except where noted, all TRS-80 Model I software is available on cassette (only) for the TRS-80 Model III. Exceptions: VALDEZ, CRIBBAGE, GRAFIX, CHESSMASTER. TRS-80 diskettes are not supplied with either DOS or BASIC.*

****For most North Star disk-based systems. DYNACOMP presently does not support the new North Star Advantage.*

*****For Altair systems having Microsoft BASIC.*

DYNACOMP OFFERS THE FOLLOWING

- Widest variety
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STARTREK 3.2 (Available for all computers) — Price: $11.95 Cassette/$15.95 Diskette
This is the classic Startrek simulation, but with several new features. For example, the Klingons now shoot at the Enterprise without warning while also attacking starbases in other quadrants. The Klingons also attack with both light and heavy cruisers and move when shot at! The situation is hectic when the Enterprise is besieged by three heavy cruisers and a starbase S.O.S. is received! The Klingons get even! See the software reviews in A.N.A.L.O.G., 80 Software Critique and Game Merchandising.

NEW **LIL' MEN FROM MARS (Atari only)** — Price: $19.95 Cassette/$23.95 Diskette
Defend yourself! The little men from Mars are out to get you if you don't get them first. This is a hilarious high resolution animated graphics (arcade) game which exercises much of the Atari's power. Requires one joystick.

SPACE TILT (Apple and Atari only) — Price: $10.95 Cassette/$14.95 Diskette
Use the game paddles to tilt the plane of the TV screen to "roll" a ball into a hole in the screen. Sound simple? Not when the hole gets smaller and smaller! A built-in timer allows you to measure your skill against others in this habit-forming action game.

NEW **ESCAPE FROM VOLANTIUM (Atari only)** — Price: $15.95 Cassette/$19.95 Diskette
Bring the action and excitement of an arcade into your home with ESCAPE FROM VOLANTIUM! To escape you must maneuver your space ship around obstacles and laser blast the dragon (without being eaten). If he is killed with a direct shot (not just a leg lopped off), a door opens to the outside. However, the door does not stay open indefinitely. If you fail to escape in time, the door closes and a new dragon appears. Sometimes you can smash through the door by repeatedly chipping away at it. Other times it is impervious. At the higher levels of play more obstacles and dragons appear, adding to the excitement. Uses high resolution graphics and sound. Runs in 16K.

ALPHA FIGHTER (Atari only) — Price: $13.95 Cassette/$17.95 Diskette
Two excellent graphics and action programs in one! ALPHA FIGHTER requires you to destroy the alien starships passing through your sector of the galaxy. ALPHA BASE is in the path of an alien UFO invasion; let five UFO's get by and the game ends. Both games require the joystick and get progressively more difficult the higher you score! ALPHA FIGHTER will run on 16K systems.

THE RINGS OF THE EMPIRE (Atari only) — Price: $15.95 Cassette/$19.95 Diskette
The empire has developed a new battle station protected by rotating rings of energy. Each time you blast through the rings and destroy the station, the empire develops a new station with more protective rings. This exciting game runs on 16K systems, employs extensive graphics and sound and can be played by one or two players.

INTRUDER ALERT (Atari only) — Price: $15.95 Cassette/$19.95 Diskette
This is a fast paced graphics game which places you in the middle of the "Dreadstar" having just stolen its plans. The droids have been alerted and are directed to destroy you at all costs. You must find and enter your ship to escape with the plans. Five levels of difficulty are provided. INTRUDER ALERT requires a joystick and will run on 16K systems.

NEW **MIDWAY (Atari only)** — Price: $14.95 Cassette/$18.95 Diskette
MIDWAY is an exciting extension of the game of Battleship. It mixes the challenges of strategy and chance. Your opponent can be another human or the computer. Color graphics and sound are both included. Runs in 16K.

TRIPLE BLOCKADE (Atari only) — Price: $14.95 Cassette/$18.95 Diskette
TRIPLE BLOCKADE is a two-to-three player graphics and sound action game. It is based on the classic video arcade game which millions have enjoyed. Using the Atari joysticks, the object is to direct your blockading line around the screen without running into your opponent(s). Although the concept is simple, the combined graphics and sound effect lead to "high anxiety".

GAMES PACK I (Available for all computers) — Price: $10.95 Cassette/$14.95 Diskette
GAMES PACK I contains the classic computer games of BLACKJACK, LUNAR LANDER, CRAPS, HORSERACE, SWITCH and more. These games have been combined into one large program for ease in loading. They are individually accessed by a convenient menu. This collection is worth the price just for the DYNACOMP version of BLACKJACK.

GAMES PACK II (Available for all computers) — Price: $10.95 Cassette/$14.95 Diskette
GAMES PACK II includes the games CRAZY EIGHTS, JOTTO, ACEY-DUCEY, LIFE, WUMPUS and others. As with GAMES PACK I, all the games are loaded as one program and are called from a menu. You will particularly enjoy DYNACOMP's version of CRAZY EIGHTS.

Why pay $7.95 or more per program when you can buy a DYNACOMP collection for just $10.95?

MOON PROBE (Atari and North Star only) — Price: $11.95 Cassette/$15.95 Diskette
This is an extremely challenging "lunar lander" program. The user must drop from orbit to land at a predetermined target on the moon's surface. You control the thrust and orientation of your craft plus direct the rate of descent and approach angle. Runs in 16K Atari.

SPACE TRAP (Atari only, 16K) — Price: $14.95 Cassette/$18.95 Diskette
This galactic "shoot'em up" arcade game places you near a black hole. You control your spacecraft using the joystick and attempt to blast as many of the aliens as possible before the black hole closes about you.

NEW **CHIRP INVADERS (PET/CBM only)** — Price: $14.95 Cassette/$18.95 Diskette
CHIRP INVADERS is an addictive game using action graphics. A Federation space station must be reached before the Chirps conquer the Earth. Stationary obstacles, moving meteors, and the attacking Chirps must all be avoided for a successful journey. Good luck.

ADVENTURE

CRANSTON MANOR ADVENTURE (North Star and CP/M only) — Price: $19.95 Diskette
At last! A comprehensive Adventure game for North Star and CP/M systems. CRANSTON MANOR ADVENTURE takes you into mysterious CRANSTON MANOR where you attempt to gather fabulous treasures. Lurking in the manor are wild animals and robots who will not give up the treasures without a fight. The number of rooms is greater and the associated descriptions are much more elaborate than the current popular series of Adventure programs, making this game the top in its class. Play can be stopped at any time and the status stored on diskette. Not available in 5¼" CP/M format.

GUMBALL RALLY ADVENTURE (North Star only, 48K) — Price: $21.95 Diskette
Take part in this outlaw race from the east coast to the west coast. The goal is to find your way to the finish line while maintaining the highest possible speed. You may choose one of five cars available at the garage. The choice will affect your speed and range. Remember to take spare parts and don't get caught speeding!

NEW **UNCLE HARRY'S WILL (North Star only, 40K)** — Price: $24.95 Diskette
Uncle Harry has died and has left you everything. However, he has neglected to mention where everything is! Instead, his will consists of a poem which contains clues. You will have to travel all over the United States both by car and on foot to solve the puzzle, and there are over 300 locations to probe. Be careful and watch out for red herrings!

SPEECH SYNTHESIS

DYNACOMP is now distributing the new and revolutionary TYPE-'N-TALK™ (TNT) speech synthesizer from Votrax. Simply connect TNT to your computer's serial interface, enter text from the keyboard and hear the words spoken. TNT is the easiest-to-program speech synthesizer on the market. It uses the least amount of memory and provides the most flexible vocabulary available anywhere!

List price $375. DYNACOMP'S price $319.95 plus $5.00 for shipping and handling.

TALK TO ME (T'N'T Atari only, 24K) — Price: $14.95 Cassette/$18.95 Diskette
This program presents a superb tutorial on speech synthesis using the Atari 800 and TYPE 'N TALK™. TALK TO ME will illustrate normal word generation as well as phoneme generation. The documentation includes many helpful programming tips. TALK TO ME has been demonstrated on network (CBS) TV!

MISCELLANEOUS

CRYSTALS (Atari only) — Price: $ 9.95 Cassette/$13.95 Diskette
A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari. Runs in 16K Atari.

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY
DYNACOMP now distributes the 23 volume NSSE library. These diskettes each contain many programs and offer an outstanding value for the purchase price. They should be part of every North Star user's collection. Call or write DYNACOMP for details regarding the contents of the NSSE collection.

Price: $9.95 each/$7.95 each (4 or more)
The complete collection may be purchased for $149.95

BUSINESS and UTILITIES

NEW **MAILMASTER (Atari diskette only)** — **Price: $39.95 Diskette**
MAILMASTER is a very versatile software package for managing and manipulating mail lists and mini data bases. Each disk can hold over 700 customer entries containing name, address, three 3-letter key words and a phone number. The display is marked so that entries may be made and edited with ease. The status (e.g., disk space left, options, etc.) is shown at all times. Labels may be printed 1,2 or 3 up, and all sorting (zip code and alphabetic) is performed by a fast machine language program.

PERSONAL FINANCE SYSTEM (Atari and North Star only) — **Price: $39.95 Diskette**
PFS is a single diskette, menu-oriented system composed of ten different programs. Besides recording your expenses and tax deductible items, PFS will sort and summarize expenses by payee, and display information on expenditures by any of 26 user defined codes by month or by payee. PFS will even produce monthly bar graphs of your expenses by category! This powerful package requires only one disk drive, minimal memory (24K Atari, 32K North Star) and will store up to 600 records per disk (and over 1000 records per disk by making a few simple changes to the programs). You can record checks plus cash expenses so that you can finally see where your money goes and eliminate guesswork and tedious hand calculations. Contains high speed machine language sort. PFS has been demonstrated on network (CBS) TV!

FAMILY BUDGET (Apple and Atari only) — **Price: $34.95 Diskette**
FAMILY BUDGET is a very convenient financial record-keeping program. You will be able to keep track of cash and credit expenditures as well as income on a daily basis. You can record tax deductible items and charitable donations. FAMILY BUDGET also provides a continuous record of all credit transactions. You can make daily cash and charge entries to any of 21 different expense accounts as well as to 5 payroll and tax accounts. Data are easily retrieved giving the user complete control over an otherwise complicated (and unorganized!) subject.

INTELINK (Atari only) — **Price: $49.95 Diskette**
This software package contains a menu-driven collection of programs for facilitating efficient two-way communications through a full duplex modem (required for use). In one mode of operation you may connect to a data service (e.g., The SOURCE or MicroNet) and quickly load data such as stock quotations onto your diskette for later viewing. This greatly reduces "connect time" and thus the service charge. You may also record the complete contents of a communications session. Additionally, programs written in BASIC, FORTRAN, etc. may be built off-line using the support text editor and later "uploaded" to another computer, making the Atari a *very* smart terminal. Even Atari BASIC programs may be uploaded. Further, a command file may be built off-line and used later as controlling input for a time-share system. That is, you can set up your sequence of time-share commands and programs, and the Atari will transmit them as needed; batch processing. All this adds up to saving both connect time and your time.

TEXT EDITOR II (CP/M) — **Price: $29.95 Diskette/$33.45 Disk**
This is the second release version of DYNACOMP's popular TEXT EDITOR I and contains many new features. With TEXT EDITOR II you may build text files in chunks and assemble them for later display. Blocks of text may be appended, inserted or deleted. Files may be saved on disk/diskette in right justified/centered format to be later printed by either TEXT EDITOR II or the CP/M ED facility. Futher, ASCII CP/M files (including BASIC and assembly language programs) may be read by the editor and processed. In fact, text files can be built using ED and later formatted using TEXT EDITOR II. All in all, TEXT EDITOR II is an inexpensive, easy to use, but very flexible editing system.

NEW **PAYFIVE (Apple II plus diskette, two drives required)** — **Price: $149.95**
This is an enormously flexible employee payroll system with extraordinarily good human engineering features. PAYFIVE prints checks and compiles the required federal, state and local forms for up to 148 employees. The pay methods may be hourly, salary, commission or any combination. There are multiple options for pay periods, and they also can be used in any combination. PAYFIVE includes *many* other features and comes extremely well documented with a 200 page manual. The manual may be purchased separately for $30, and that payment later applied to the software purchase.

SHOPPING LIST (Atari only) — **Price: $12.95 Cassette/$16.95 Diskette**
SHOPPING LIST stores information on items you purchase at the supermarket. Before going shopping, it will remind you of all the things you might need, and then display (or optionally print) your shopping list and the total cost. Adding, deleting, changing and storing data is very easy. Runs with 16K.

TAX OPTIMIZER (North Star only) — **Price: $59.95 Diskette**
The TAX OPTIMIZER is an easy-to-use, menu oriented software package which provides a convenient means for analyzing various income tax strategies. The program is designed to provide a quick and easy data entry. Income tax is computed by all tax methods (regular, income averaging, maximum and alternate minimum tax). The user may immediately observe the tax effect of critical financial decisions. TAX OPTIMIZER has been thoroughly field tested in CPA offices and comes complete with the current tax tables in its data files. TAX OPTIMIZER is tax deductible!

NEW **UTIL (Apple only, 48K)** — **Price: $19.95 Diskette**
UTIL is a disk-oriented utility system which permits examining and changing of the contents of DOS 3.2 and 3.3 diskettes at the bit (nibble or byte) level. With UTIL you can easily examine the contents of a diskette sector by sector, restructure the sector pointers, reallocate sectors (e.g. bad sectors may be "hidden"), and perform many other sophisticated operations. For the experienced programmer.

NEW **TURNKEY AND MENU (Atari only)** — **Price: $17.95 Diskette**
TURNKEY is a utility program which allows you to create autoboot/autorun diskettes easily. Simply load and run TURNKEY, load the program diskette to be modified, and answer the questions! The TURNKEY diskette also comes with DOS 2.0 and includes another program, MENU. MENU lists the contents of your diskette alphabetically, and permits the running of any BASIC program on the diskette by typing a single key. TURNKEY and MENU provide you with the ability to run any program on your diskette by simply turning on the computer and pressing a single key.

NEW **STOCKAID (Atari only)** — **Price: $29.95 Diskette**
STOCKAID provides a powerful set of tools for stock market analysis. With STOCKAID you can display point and figure charts, as well as bar charts with oscillators. You can also examine long term moving averages and on-balance volume features. STOCKAID allows you to input daily data with a single diskette storage capability of 239 days × 16 stocks. Included are stock dividend and split adjustment capabilities. A very professional package!

NEW **SHAPE MAGICIAN (Apple II, 48K, diskette only)** — **Price: $29.95**
At last! An utility for painlessly creating graphics shapes for the Apple. Create, edit and save up to 30 shapes which can then be used to develop arcade games or to simply enhance your programs. Add that professional touch!

EDUCATION

HODGE PODGE (Apple only, 48K Applesoft or Integer BASIC) — **Price: $14.95 Cassette/$18.95 Diskette**
Let HODGE PODGE be your child's teacher. Pressing any key on your Apple will result in a different and intriguing "happening" related to the letter or number of the chosen key. The program's graphics, color and sound are a delight for children from ages 1½ to 7. HODGE PODGE is a non-intimidating teaching device which brings a new dimension to the use of computers in education. See the excellent reviews of this very popular program in INFOWORLD and SOFTALK.

NEW **TEACHER'S AIDE (Atari only)** — **Price: $13.95 Cassette/$17.95 Diskette**
TEACHER'S AIDE consists of three basic modules contained in one program. The first module provides addition and subtraction exercises of varying levels of difficulty. The second module consists of multiplication problems in which the student may be tested both on the final answer and/or on the subtotal answers in the long hand procedure. Several levels of complexity are provided here as well. The third module consists of division problems; one particularly nice feature of the division module is that the long hand division steps can be displayed along with the remainder in order to clearly demonstrate the procedure by which the remainder is derived. Using TEACHER'S AIDE is not merely a drill, but rather a learning experience.

NEW **PHARMACOLOGY UPDATE (PET only)** — **Price: $149.95 Cassette/$153.95 Diskette**
This is DYNACOMP's first educational software entry for the medical profession (more are coming!). PHARMACOLOGY UPDATE was written by a R.N. as a masters project, with the aid of a practicing pharmacologist and an electronics instructor. This package comes in two parts. The first part is a 200 page manual which is divided into 10 sections. Each of these sections provides both concise information and probing questions. The second part consists of 10 programs that are keyed to the text and which test the degree of your understanding of the text material. This package has great educational value for the beginning student as well as the professional interested in an efficient way to review and update his or her knowledge.

ORDERING INFORMATION

All orders are processed and shipped within 48 hours. Please enclose payment with order and include the appropriate computer information. If paying by VISA or Master Card, include all numbers on card. Purchase orders accepted.

Shipping and Handling Charges
Within North America: Add $2.00
Outside North America: Add 15% (Air Mail)

Delivery
All orders (excluding books) are sent First Class.

Quantity Discounts
Deduct 10% when ordering 3 or more programs. Dealer discount schedules are available upon request.

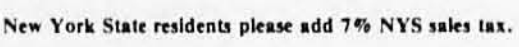
8" CP/M Disks
Add $2.50 to the listed diskette price for each 8" floppy disk (IBM soft sectored CP/M format). Programs run under Microsoft MBASIC or BASIC-80.

5¼" CP/M Disks
All software available on 8" CP/M disks is also available on 5¼" disks, North Star and Osborne format.

Ask for DYNACOMP programs at your local software dealer. Write for detailed descriptions of these and other programs from DYNACOMP.

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1427 Monroe Avenue
Rochester, New York 14618
24 hour order phone: (716)442-8731 recording
Office phone (9AM-5PM EST): (716)442-8960




New York State residents please add 7% NYS sales tax.



STATISTICS and ENGINEERING

DIGITAL FILTER (Available for all computers) — **Price: $39.95 Cassette/$43.95 Diskette**
DIGITAL FILTER is a comprehensive data processing program which permits the user to design his own filter function or choose from a menu of filter forms. The filter forms are subsequently converted into non-recursive convolution coefficients which permit rapid data processing. In the explicit design mode the shape of the frequency transfer function is specified by directly entering points along the desired filter curve. In the menu mode, ideal low pass, high pass and bandpass filters may be approximated to varying degrees according to the number of points used in the calculation. These filters may optionally also be smoothed with a Hanning function. In addition, multi-stage Butterworth filters may be selected. Features of DIGITAL FILTER include plotting of the data before and after filtering, as well as display of the chosen filter functions. Also included are convenient data storage, retrieval and editing procedures.

DATA SMOOTHER (Not available for Atari) — **Price: $19.95 Cassette/$23.95 Diskette**
This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — **Price: $19.95 Cassette/$23.95 Diskette**
Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — **Price: $19.95 Cassette/$23.95 Diskette**
This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

HARMONIC ANALYZER (Available for all computers) — **Price: $24.95 Cassette/$28.95 Diskette**
HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include data file generation, editing and storage/retrieval as well as data and spectrum plotting. One particularly unique facility is that the input data need not be equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required by the FFT algorithm.

FOURIER ANALYZER, TFA and HARMONIC ANALYZER may be purchased together for a combined price of $49.95 (three cassettes) and $59.95 (three diskettes).

REGRESSION I (Available for all computers) — **Price: $19.95 Cassette/$23.95 Diskette**
REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy; an automatic degree determination option; an extensive internal library of fitting functions; data editing; automatic data, curve and residual plotting; a statistical analysis (eg: standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certainly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — **Price: $19.95 Cassette/$23.95 Diskette**
PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data, results and residuals may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

MULTILINEAR REGRESSION (MLR) (Available for all computers) — **Price: $24.95 Cassette/$28.95 Diskette**
MLR is a professional software package for analyzing data sets containing two or more linearly independent variables. Besides performing the basic regression calculation, this program also provides easy to use data entry, storage, retrieval and editing functions. In addition, the user may interrogate the solution by supplying values for the independent variables. The number of variables and data size is limited only by the available memory.

REGRESSION I, II and MULTILINEAR REGRESSION may be purchased together for $51.95 (three cassettes) or $63.95 (three diskettes).

ANOVA (Not available on Atari cassette or for PET/CBM) — **Price: $39.95 Cassette/$43.95 Diskette**
In the past the ANOVA (analysis of variance) procedure has been limited to the large mainframe computers. Now DYNACOMP has brought the power of this method to small systems. For those conversant with ANOVA, the DYNACOMP software package includes the 1-way, 2-way and N-way procedures. Also provided are the Yates 2^{K-P} factorial designs. For those unfamiliar with ANOVA, do not worry. The accompanying documentation was written in a tutorial fashion (by a professor in the subject) and serves as an excellent introduction to the subject. Accompanying ANOVA is a support program for building the data base. Included are several convenient features including data editing, deleting and appending.

BASIC SCIENTIFIC SUBROUTINES, Volumes 1 and 2 (Not available for Atari)
DYNACOMP is the exclusive distributor for the software keyed to the popular texts *BASIC SCIENTIFIC SUBROUTINES, Volumes 1 and 2* by F. Ruckdeschel (see advertisements in BYTE magazine). These subroutines have been assembled according to chapter. Included with each collection is a menu program which selects and demonstrates each subroutine.

Volume 1
Collection #1: Chapters 2 and 3 - Data and function plotting; complex variables and functions.
Collection #2: Chapter 4 - Extended matrix and vector operations.
Collection #3: Chapters 5 and 6 - Random number generators (Poisson, Gaussian, etc.); series approximations.
Price per collection: $14.95 Cassette/$18.95 Diskette
All three collections are available for $39.95 (three cassettes) and $49.95 (three diskettes).

Volume 2
Collection #1: Chapter 1 - Linear, polynomial, multidimensional, parametric least squares.
Collection #2: Chapter 2 - Series approximation techniques (economization, inversion, reversion, shifting, etc.).
Collection #3: Chapter 3 - Functional approximations by iteration and recursion.
Collection #4: Chapter 4 - CORDIC approximations to trigonometric, hyperbolic, exponential and logarithmic functions.
Collection #5: Chapter 5 - Table interpolation, differentiation and integration (Newton, LaGrange, splines).
Collection #6: Chapter 6 - Methods for finding the real roots of functions.
Collection #7: Chapter 7 - Methods for finding the complex roots of functions.
Collection #8: Chapter 8 - Optimization by steepest descent.
Price per collection: $14.95 Cassette/$18.95 Diskette
All eight collections are available for $99.95 (eight cassettes) and $129.95 (eight diskettes).
Because the texts are a vital part of the documentation, *BASIC SCIENTIFIC SUBROUTINES, Volumes 1 and 2* are available from DYNACOMP:

BASIC SCIENTIFIC SUBROUTINES, Vol 1 (319 pages): $19.95 + 75¢ postage
BASIC SCIENTIFIC SUBROUTINES, Vol 2 (790 pages): $23.95 + $1.50 postage

See reviews in KILOBAUD and Dr. Dobbs.

NEW **SOFTNET (Apple II 48K, diskette only)** — **Price $129.95**
SOFTNET may be used to create models of liquid pipeline systems to evaluate their flow performance. Up to 150 nodes with up to 150 connecting elements may be simulated, and models may be combined to form yet larger models. If you are involved in water distribution systems, chemical fluid flow problems, building plumbing, or similar situations, this is an ideal analysis tool.

ACTIVE CIRCUIT ANALYSIS (ACAP) (48K Apple only) — **Price: $25.95 Cassette/$29.95 Diskette**
ACAP is the analog circuit designer's answer to LOGIC SIMULATOR. With ACAP you may analyze the response of an active or passive component circuit (e.g., a transistor amplifier, band pass filter, etc.). The circuit may be probed at equal steps in frequency, and the resulting complex (i.e., real and imaginary) voltages at each component juncture examined. By plotting the magnitude of these voltages, the frequency response of a filter or amplifier may be completely determined with respect to both amplitude and phase. In addition, ACAP prints a statistical analysis of the range of voltage responses which result from tolerance variations in the components. ACAP is easy to learn and use. Simply describe the circuit in terms of the elements and their placement, and execute. Circuit descriptions may be saved onto cassette or diskette to be recalled at a later time for execution or editing. ACAP should be part of every circuit designer's program library.

LOGIC SIMULATOR (Apple only; 48K RAM) — **Price: $24.95 Cassette/$28.95 Diskette**
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Programming Quickies

A Shape-Drawing Program for Diablo Printers

Thomas D. Brock
1227 Dartmouth Rd.
Madison, WI 53705

The Diablo Model 1620 and 1640 daisy-wheel printers have a lot of nice graphics features that aren't generally used. After working with high-resolution graphics shape tables on the Apple II computer, I decided to write a shape-list generator for the Diablo in BASIC. [*We call this construct a "shape list" to distinguish it from the binary-coded Apple shape tables....***RSS**]

The program I devised permits the definition of a variety of shapes and the printing of these shapes at any chosen size. No attempt has been made to write a complete graphics package, but the shape-list generator could easily be incorporated into a larger program. Changing the position of printing on the paper and rotating the shapes could also be added.

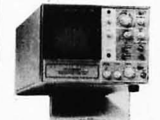
Each shape is defined in terms of the instructions needed to print it on the paper. The move and print instructions are coded into character strings that are interpreted by a series of subroutines. The program can be used on any BASIC interpreter that supports string variables and permits dissection of strings into substrings.

The details of the Diablo codes for graphics can be found in the Diablo user's manual. The printer is placed into graphics mode by sending to it an Escape, "3" sequence and is taken out of graphics mode through an Escape, "4" sequence. When in graphics mode, carriage movement is not tied to character printing, but space and backspace cause carriage movements of 1/60 inch forward and backward, respectively. Also the linefeed character causes paper-feed movement of 1/48 inch, and "negative linefeed," initiated by sending an Escape, linefeed sequence, causes paper movement of 1/48 inch in the opposite direction. Other paper-movement commands such as vertical tab, formfeed, and margin control remain unchanged.

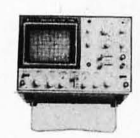
Thus, to print a horizontal line, it is necessary to send an alternating sequence of periods (decimal ASCII code 46) and spaces or backspaces; the length of the line in inches will be 1/60 times the number of periods printed. To print a vertical line, one sends an alternating sequence of periods and linefeeds, or negative linefeeds; the length

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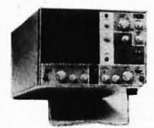


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15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	10.0M

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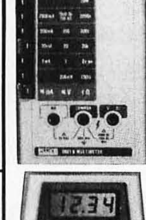
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Listing 1: *Diablo printer shape-table program in BASIC for the Apple II computer.*

```
1   REM  DIABLO SHAPE TABLE GENERATOR
2   REM  BY THOMAS D. BROCK, MADISON, WI.
3   REM  FIRST DEFINE CODES FOR DIABLO.  E$=ESCAPE.SP$=SPACE.
4   REM  LF$=LINE FEED.G$=3.TX$=4.PE$=PERIOD (PRINT CHARACTER).
5   REM  BS$=BACKSPACE.NF$=NEGATIVE LINE FEED.
10 E$ =  CHR$ (27):SP$ =  CHR$ (32):LF$ =  CHR$ (10):G$ =  CHR$ (51)
11 TX$ =  CHR$ (52):PE$ =  CHR$ (46):BS$ =  CHR$ (8)
12 NF$ =  CHR$ (27) +  CHR$ (10)
19  REM  SHAPE TABLE REFERENCES
20  INPUT "SHAPE#?";N
22  INPUT "SCALE?";S
28  REM  TURN ON PRINTER.INITIALIZE GRAPHICS MODE
30  PR# 3: PRINT " ";E$;G$;
40  ON N GOSUB 1000,1100,1200,1300
45  GOTO 200
48  REM  MOVE AND PRINT ROUTINES
50  FOR I = 1 TO M * S
52  PRINT SP$;PE$;
54  NEXT I: RETURN
60  FOR I = 1 TO M * S
62  PRINT LF$;PE$;
64  NEXT I: RETURN
70  FOR I = 1 TO M * S
72  PRINT BS$;PE$;
74  NEXT I: RETURN
80  FOR I = 1 TO M * S
82  PRINT NF$;PE$;
84  NEXT I: RETURN
198  REM  RETURN TO TEXT MODE
200  PRINT E$;TX$;: PR# 0: END
998  REM  LINES 1000,1200 DEFINE SHAPES
999  REM  ANY SHAPES MAY BE INSERTED HERE
1000 SH$ = "L3D3R2XL2D3R3"
1001  GOSUB 5000: RETURN
1100 SH$ = "XD3L2U4R4D4L2"
1101  GOSUB 5000: RETURN
1200 SH$ = "XD3L2XL1XU1U3XU1XR1R3XR1XD1D3XD1XL1L2": GOSUB 5000: RETURN
1998  REM  TEST FOR PRINT DIRECTION
2000  IF M$ = "R" THEN  GOSUB 50
2010  IF M$ = "D" THEN  GOSUB 60
2020  IF M$ = "L" THEN  GOSUB 70
2030  IF M$ = "U" THEN  GOSUB 80
2040  RETURN
4998  REM  INTERPRET STRING AS SHAPE
5000  FOR J = 1 TO  LEN (SH$)
5020  IF  MID$ (SH$,J,1) = "X" THEN PE$ =  CHR$ (0):J = J + 1
5030 M$ =  MID$ (SH$,J,1):J = J + 1:M =  VAL ( MID$ (SH$,J,1)): GOSUB 2000
5100 PE$ =  CHR$ (46): NEXT J
5200  RETURN
```

of the vertical line in inches will be 1/40 times the number of periods printed. To move the print head without printing a line, the print-head-movement command is sent without the corresponding periods.

The program in listing 1 is fairly self-explanatory. The shapes are stored as character strings in lines 1000 to 1200, and could, of course, also be input just before starting execution by a change in line 20.

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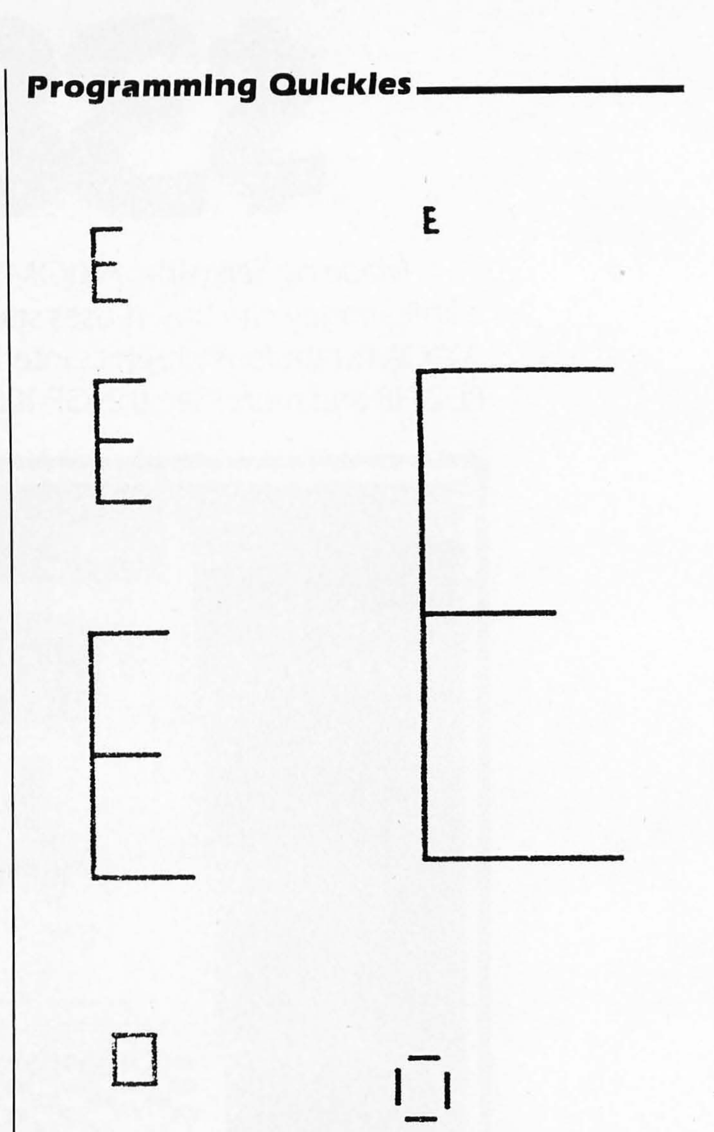


Figure 1: *Sample printout produced on a Diablo printer of the 1600 series with the program of listing 1.*

The shape string selected is interpreted in the subroutine at line 5000. If an *X* is present, it means move without printing, an *R* means move right, an *L* means move left, a *U* means move up, and a *D* means move down. The number after the move instruction provides the relative amount of movement, which is stored in the variable *M*.

The actual amount of movement depends upon the size of the shape, selected at line 22. The whole shape is quickly printed by the program. Printing is then stopped so that another instruction can be fetched, if desired. A typical printout is shown in figure 1.

Although the Diablo printer has several different ways by which graphics can be created, the shape-list program provides a simple means to make nonnumerical drawings. By permitting the selection of any desired size (and position on the paper, with routines easily added) some useful tasks can be performed. Because of the simplicity and shortness of the program, it can be run with virtually any BASIC interpreter that supports string functions.■

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6	BREAKEVN	Breakeven analysis
7	DEPRSL	Straightline depreciation
8	DEPRSY	Sum of the digits depreciation
9	DEPRDB	Declining balance depreciation
10	DEPRDDB	Double declining balance depreciation
11	TAXDEP	Cash flow vs. depreciation tables
12	CHECK2	Prints NEBS checks along with daily register
13	CHECKBK1	Checkbook maintenance program
14	MORTGAGE/A	Mortgage amortization table
15	MULTMON	Computes time needed for money to double, triple, etc.
16	SALVAGE	Determines salvage value of an investment
17	RRVARIN	Rate of return on investment with variable inflows
18	RRCONST	Rate of return on investment with constant inflows
19	EFFECT	Effective interest rate of a loan
20	FVAL	Future value of an investment (compound interest)
21	PVAL	Present value of a future amount
22	LOANPAY	Amount of payment on a loan
23	REGWITH	Equal withdrawals from investment to leave 0 over
24	SIMPDISK	Simple discount analysis
25	DATEVAL	Equivalent & nonequivalent dated values for oblig.
26	ANNUDEF	Present value of deferred annuities
27	MARKUP	% Markup analysis for items
28	SINKFUND	Sinking fund amortization program
29	BONDVAL	Value of a bond
30	DEPLETE	Depletion analysis
31	BLACKSH	Black Scholes options analysis
32	STOCVAL1	Expected return on stock via discounts dividends
33	WARVAL	Value of a warrant
34	BONDVAL2	Value of a bond
35	EPSEST	Estimate of future earnings per share for company
36	BETAALPH	Computes alpha and beta variables for stock
37	SHARPE1	Portfolio selection model-i.e. what stocks to hold
38	OPTWRITE	Option writing computations
39	RTVAL	Value of a right
40	EXPVAL	Expected value analysis
41	BAYES	Bayesian decisions
42	VALPRINF	Value of perfect information
43	VALADINF	Value of additional information
44	UTILITY	Derives utility function
45	SIMPLEX	Linear programming solution by simplex method
46	TRANS	Transportation method for linear programming
47	EOQ	Economic order quantity inventory model
48	QUEUE1	Single server queueing (waiting line) model
49	CVP	Cost-volume-profit analysis
50	CONDPROF	Conditional profit tables
51	OPTLOSS	Opportunity loss tables
52	FQUOQ	Fixed quantity economic order quantity model

	NAME	DESCRIPTION
53	FQEOWSH	As above but with shortages permitted
54	FQEOQPB	As above but with quantity price breaks
55	QUEUECB	Cost-benefit waiting line analysis
56	NCFANAL	Net cash-flow analysis for simple investment
57	PROFIND	Profitability index of a project
58	CAP1	Cap. Asset Pr. Model analysis of project
59	WACC	Weighted average cost of capital
60	COMPBAL	True rate on loan with compensating bal. required
61	DISCBAL	True rate on discounted loan
62	MERGANAL	Merger analysis computations
63	FINRAT	Financial ratios for a firm
64	NPV	Net present value of project
65	PRINDLAS	Laspeyres price index
66	PRINDPA	Paasche price index
67	SEASIND	Constructs seasonal quantity indices for company
68	TIMETR	Time series analysis linear trend
69	TIMEMOV	Time series analysis moving average trend
70	FUPRINF	Future price estimation with inflation
71	MAILPAC	Mailing list system
72	LETWRT	Letter writing system-links with MAILPAC
73	SORT3	Sorts list of names
74	LABEL1	Shipping label maker
75	LABEL2	Name label maker
76	BUSBUD	DOME business bookkeeping system
77	TIMECLCK	Computes weeks total hours from timeclock info.
78	ACCTPAY	In memory accounts payable system-storage permitted
79	INVOICE	Generate invoice on screen and print on printer
80	INVENT2	In memory inventory control system
81	TELDIR	Computerized telephone directory
82	TIMUSAN	Time use analysis
83	ASSIGN	Use of assignment algorithm for optimal job assign.
84	ACCTREC	In memory accounts receivable system-storage ok
85	TERMSPAY	Compares 3 methods of repayment of loans
86	PAYNET	Computes gross pay required for given net
87	SELLPR	Computes selling price for given after tax amount
88	ARBCOMP	Arbitrage computations
89	DEPRSF	Sinking fund depreciation
90	UPSZONE	Finds UPS zones from zip code
91	ENVELOPE	Types envelope including return address
92	AUTOEXP	Automobile expense analysis
93	INSFILE	Insurance policy file
94	PAYROLL2	In memory payroll system
95	DILANAL	Dilution analysis
96	LOANAFFD	Loan amount a borrower can afford
97	RENTPRCH	Purchase price for rental property
98	SALELEAS	Sale-leaseback analysis
99	RRCONVBD	Investor's rate of return on convertable bond
100	PORTVAL9	Stock market portfolio storage-valuation program

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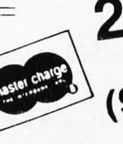
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Four Implementations of Pascal

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The programming language Pascal was developed in the late 1960s and early 1970s by Niklaus Wirth. According to Wirth, principal aims were to create a language suitable for teaching and facilitating disciplined and systematic programming and to develop reliable and efficient implementations of the language on computers then available. Here, we review four implementations of Pascal designed for today's microcomputers. Three of these—Pascal/M, Pascal/MT+, and Pascal/Z—are designed to operate under the CP/M operating system; the fourth, Softech's UCSD Pascal, is an entire operating system designed to run on a variety of microcomputers, including Z80-based machines.

Wirth's Pascal, or standard Pascal, is defined in the *Pascal User Manual and Report* (K. Jensen and N. Wirth. New York: Springer Verlag, second edition, 1974) and is the common basis for the implementations considered. Each implementation is essentially a superset of this standard and incorporates features of the proposed International Standards Organization (ISO) draft proposal for the language, ISO/DP 7185. The ISO proposal extends Wirth's Pascal.

Differences in Implementations

The four implementations of Pascal described here differ chiefly with respect to these kinds of features:

- Extensions to the ISO standards.
- Nature of code generated, whether machine code that can be directly executed in the target processor, or P-code (pseudo-machine code, also called intermediate code) that must be translated into machine code by an interpreter when the program is run.
- Types and variety of input and output primitives (intrinsic procedures for input and output).
- Support for separate compilation of modules or libraries of procedures and data structures (so that the separate modules can be called and used by other programs, eliminating the need to rewrite commonly used procedures).
- Support for memory overlays (an overlay is a section of code brought into main memory in an area previously occupied by another section of the same program). An overlay reduces the amount of main memory necessary for a program to run.
- Ease of use. The nature of the code generated and the steps required to generate it do much to determine ease of use.

We will describe each of the four implementations of Pascal and then examine the way they handle some of the Pascal features just mentioned. Some of the terms used to describe programming languages are defined separately in the text box "Programming Language Terms" on page 354.

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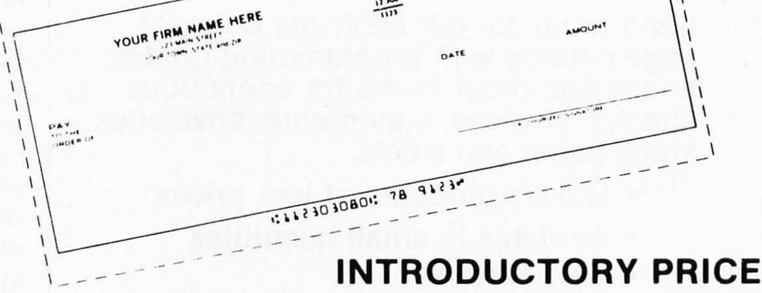
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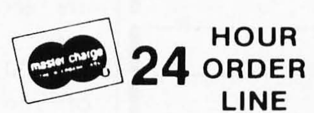
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Pascal/Z

Ithaca Intersystems' Pascal/Z is a compiler for the Z80 processor and is designed to run under Digital Research's CP/M Version 2.2 operating system. Pascal/Z requires 56K bytes of RAM (random-access memory), including the space used by the operating system and at least one disk drive. According to the developer, the Pascal/Z compiler generates optimized macro-assembler code that is capable of being written into a read-only memory device (ROM-able) and capable of being interrupted and later reentered at the point of interruption (reentrant).

To execute a Pascal program with Pascal/Z, you must compile the source text, assemble the resulting Z80 assembler code, and link the resulting code file to a run-time library. The linked code is then ready for execution under CP/M.

The Pascal/Z compiler, assembler, and linker are all part of the Pascal/Z package, retailing for $395.

Pascal/M

The Pascal/M compiler, made by Sorcim of Santa Clara, California, is a one-pass compiler that produces a P-code file as output. Pascal/M was designed to run under CP/M 2.0, MP/M, Cromemco CDOS, and Oasis operating systems on Z80 or 8080/8085 machines. Pascal/M requires 56K bytes of memory and one disk drive. The Pascal/M package includes the compiler, a run-time library, and a run-time interpreter. It costs $225. (Our thanks to Digital Marketing of Walnut Creek, California, for making a copy of Pascal/M available to us.)

Pascal/M is identical to UCSD Pascal—in all its extensions to standard Pascal—with two important exceptions. The similarity includes the naming and definition of strings and the built-in procedures for handling them, along with low-level, byte-oriented procedures for moving information from one part of memory to another.

The important differences between Pascal/M and UCSD Pascal are in the operating system and library facilities. Pascal/M operates under CP/M, but UCSD Pascal is an independent operating system. Pascal/M has no apparent facility for separate compilation of libraries of procedures; UCSD Pascal is well endowed in this regard. Pascal/M allows memory overlays.

UCSD Pascal

UCSD Pascal, originally developed at the University of California, San Diego, is supplied by Softech Microsystems Inc. of San Diego. The UCSD Pascal system requires at least 48K bytes of contiguous RAM (64K bytes are recommended) and at least 175K bytes of disk storage.

UCSD Pascal comprises an entire operating system and can run on a variety of machines. The operating system includes a file handler, a character-oriented editor, a one-pass compiler that generates P-code, a conditional macro assembler, a linker, and a librarian utility. The operating

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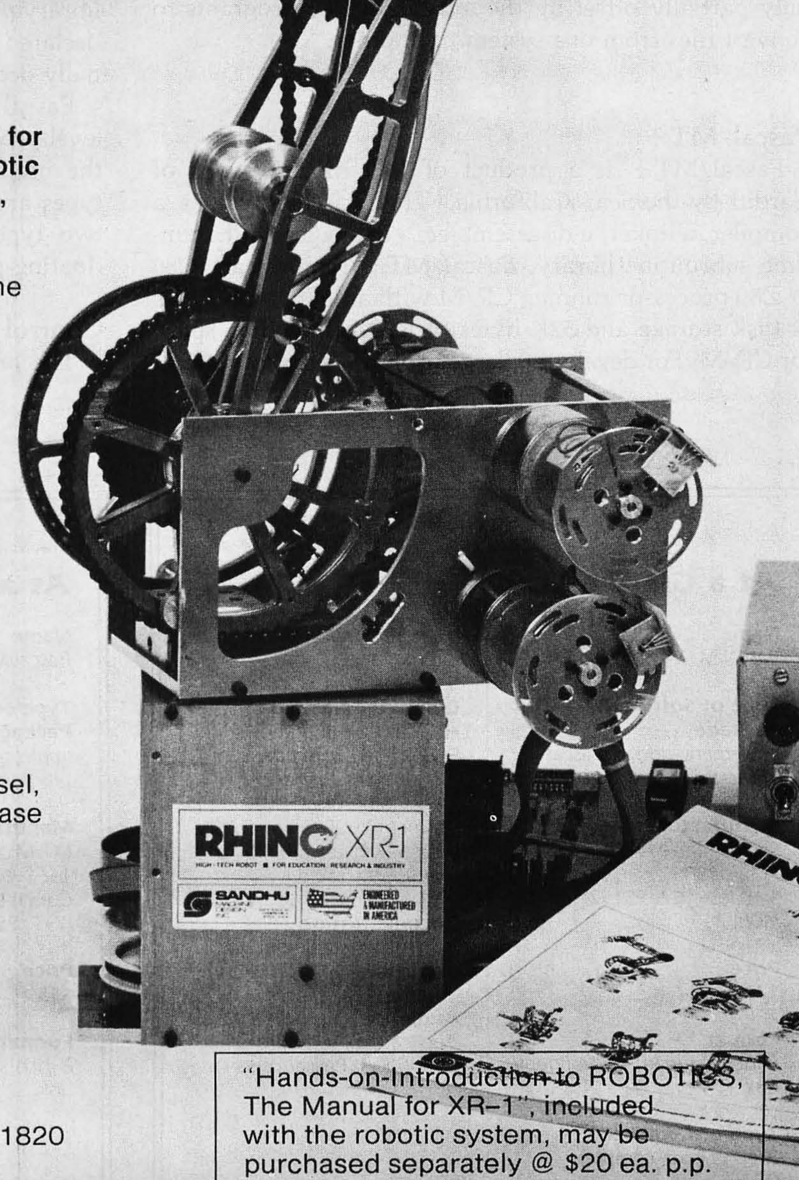
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system is written in Pascal and supported by a run-time interpreter written in the language of the host processor. The interpreter is part of the package, which retails for $500. A separate FORTRAN compiler is available for the system.

An important trade-off to be noted by CP/M users who are considering purchase of the UCSD system is its portability versus its incompatibility with CP/M. The UCSD system is portable because versions of the interpreter have been developed for a variety of microprocessors. Softech supports the system well, and this support will probably be extended to more processors in the future. The considerable advantage to the software developer is that UCSD Pascal programs can be transferred without modification from one hardware system to another.

Conversely, UCSD Pascal is incompatible with CP/M. Data files are not automatically transferable between CP/M and the UCSD system. This causes problems in maintaining the integrity of databases. The problems are only partially offset by the availability of programs to convert files from one system to another.

Pascal/MT+

Pascal/MT+ is a product of MT Microsystems of Cardiff-by-the-Sea, California. This Pascal includes a compiler, a linker, a disassembler, a debugger, and a run-time subroutine library. Pascal/MT+ requires an 8080 or Z80 processor running CP/M with at least 140K bytes of disk storage and 52K bytes of RAM, including space for CP/M. For developing large programs, a minimum of 300K bytes of disk storage and 60K bytes of RAM are suggested. The compiler generates relocatable, optimized Z80 code, or 8080 code (if desired) that must be linked to the run-time library. The Pascal/MT+ package costs $450.

Pascal/MT+ is an interesting and powerful tool. Alone among the four implementations, it supports passing of procedures and functions as parameters to other procedures and functions and supports "conformant" arrays—both features required by the ISO standard. In fact, Pascal/MT+ is the only implementation that claims full compatibility with the ISO standard.

The conformant-arrays scheme is important because there are no dynamic arrays in Pascal. The programmer must change the declaration of an array in the source program to change the bounds of the array at run time. This restriction imposes a burden on the programmer. The conformant-array scheme provides greater flexibility. For example, you can pass bounds derived by the source program to a library program, provided the array in the library program is of the same type as the array originally declared and the bounds passed are within those originally declared.

Pascal/MT+ provides several facilities for machine-level programming from Pascal and also makes possible the use of interrupts. Also, several nonstandard data types are built in. For example, Pascal/MT+ provides two types of real data: fixed-point binary-coded and floating-point.

Control Statements and Data Structures

The program control statements included in standard

At a Glance

Name
Pascal/M, Version 3.3

Type of Software Package
Implementation of Pascal programming language

Manufacturer
Sorcim
POB 32505
San Jose, CA 95152
(408) 248-5543

Price
$225

Format
8-inch standard CP/M floppy disk

Type of Compiler
Pseudo-code compiler supported by a run-time interpreter

Computer Needed
Any Z80- or 8080/8085-based computer running either CP/M Version 1.4 or later, or MP/M, Cromemco CDOS or OASIS, with 56K bytes of RAM and one floppy-disk drive

Documentation
A 77-page, staple-bound manual

Audience
Applications software developers, Pascal users

At a Glance

Name
Pascal/MT+, Version 5.2

Type of Software Package
Implementation of the Pascal programming language

Manufacturer
MT Microsystems
1562 Kings Cross Dr.
Cardiff-by-the-Sea, CA 92007
(714) 755-1366

Price
$450

Format
8-inch standard CP/M floppy disk

Type of Compiler
True Z80 compiler

Computer Needed
Any Z80- or 8080-based computer running CP/M Version 2.2 with 52K bytes of RAM (56K or more preferred) and 140K of floppy-disk storage (300K preferred)

Documentation
A 165-page, staple-bound manual

Audience
Applications software developers, Pascal users

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At a Glance

Name
Pascal/Z, Version 3.3

Type of Software Package
Implementation of Pascal programming language

Manufacturer
Ithaca Intersystems Inc.
1650 Hanshaw Rd.
POB 91
Ithaca, NY 14850
(607) 257-0190

Price
$395

Format
8-inch standard CP/M floppy disk

Type of Compiler
True Z80 compiler

Computer Needed
Any Z80-based computer running CP/M Version 2.2 with 54K bytes of RAM (64K preferred) and at least one disk drive (two drives preferred)

Documentation
A 198-page, loose-leaf bound manual

Audience
Applications software developers, Pascal users

Pascal are the WHILE...DO, REPEAT...UNTIL, IF...THEN...ELSE, the FOR...DO loop, the CASE statement, and the GOTO statement. All of these constructs are supported in the four implementations. All the implementations but UCSD Pascal have provided for an OTHERWISE clause in the CASE statement—an addition included in the ISO standard. A restricted form of GOTO (which precludes exiting the body of a procedure) is supported in all versions except Pascal/MT+, which provides unrestricted GOTOs.

The primitive data types defined in standard Pascal include integers, reals, Boolean data, user-defined scalars and subrange types, and character data. The defined, structured types include arrays, sets of scalars, pointers, record types, and files of records. Wirth's Pascal calls for text files and permits packing of structured types to conserve memory space.

All these data types and structuring techniques except packing are available in each of the four Pascals. Packing is not explicitly available in the native-code compilers Pascal/Z and Pascal/MT+. These two allocate memory in bytes, whereas the other two allocate in words; that is,

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the native-code compilers always pack data. Generally speaking then, the native-code compilers are more conservative in terms of memory needed for data than are the other two implementations, although similar and sometimes even greater conservation can be achieved by packing data in the other two.

All the versions extend standard Pascal to include a predefined string type. Strings of length N may be defined up to a maximum length of 255, and the actual length of a string may vary from 0 to N during program execution. The next section discusses built-in procedures for manipulating strings.

Pascal/M and UCSD Pascal have provided long (32-bit) integers as a predeclared data type. The operations permitted with long integers are addition, subtraction, and comparisons. Pascal/MT+ has provided two types of reals: floating-point reals and fixed-point, binary-coded decimal reals with 18 digits, four decimal. Pascal/Z provides floating-point reals and fixed-point reals with user-declared precision.

Built-in Procedures and Functions

Standard Pascal includes a number of intrinsic procedures and functions, including transcendental-arithmetic functions, memory-management procedures, and several

At a Glance

Name
UCSD Pascal, Version 2.0

Type of Software Package
Implementation of Pascal programming language, including the UCSD operating system

Manufacturer
Softech Microsystems
9494 Black Mountain Rd.
San Diego, CA 92126
(714) 578-6105

Price
$500. Note: price is for Version 4.0. We tested Version 2.0

Format
8-inch IBM 3740-compatible disk

Type of Compiler
Pseudo-code compiler supported by a run-time interpreter

Computer Needed
Any Z80-, 8080/8085-, 6502-, or 6800-based computer with 48K bytes of contiguous RAM (64K recommended) and a floppy-disk system with at least 175K bytes of online storage, or any Digital Equipment Corp. LSI-11 or PDP-11 computer

Documentation
A 450-page, paper-bound manual; includes documentation for the UCSD operating system

Audience
Applications software developers, Pascal users

Comments
The UCSD system has its own file handler and operating system, including compiler, linker, assembler, editor, and librarian utility. When the system is used on machines already equipped with CP/M, only the BIOS routines from CP/M are used. Non-CP/M users will need to write their own simplified basic input/output subsystem (SBIOS) and bootstrap module. Documentation for how to write the SBIOS is included.

input/output (I/O) procedures. We will consider the I/O procedures in a later section; for now, we will concentrate on other intrinsics and built-ins.

In standard Pascal you are permitted to dynamically allocate and deallocate memory for user-defined data types on a variable-by-variable basis. Only Pascal/MT+ fully implements this standard. In the other versions, you can allocate space on a variable-by-variable basis, but you can only deallocate blocks of memory cells at a time. In these cases, memory is a heap of undifferentiated cells; the programmer can mark the top of the heap, dynamically allocate memory to variables, and then deallocate memory back to the old top of the heap.

A useful function for dynamic-memory management is one that returns the amount of memory available at the time the function is called. Such a function can inform the programmer that allocating more memory may clobber some portion of the current program. All but Pascal/Z provide this function.

All the versions have provided built-in functions for manipulating the string types just described. Pascal/Z provides functions for appending one string to another, determining the length of a string, and finding the position of a substring within a string. The other versions have these three built-in functions, and functions for inserting, deleting, and copying substrings from a string.

UCSD Pascal, Pascal/MT+ and Pascal/M have provided several high-speed, built-in procedures for moving bytes between memory locations. You can move data between packed arrays of data and similar data structures, initialize packed arrays, and search arrays for specified bit patterns on a byte-by-byte basis.

Pascal/M, Pascal/MT+, and UCSD Pascal have a procedure called EXIT that permits clean exits from procedures, functions, and programs. A typical application would be to exit a program after flagging an egregious user error, such as bad input from the keyboard.

Pascal/M and UCSD Pascal support random screen-cursor addressing through the built-in function GOTOXY(X,Y). Pascal/M also has built-in procedures that permit homing the cursor, clearing to end of line, and so on. UCSD Pascal supplies the utility program SETUP that matches the operating system to the characteristics of the user's terminal.

Pascal/MT+ has several built-in procedures and operators for byte and bit manipulation. For example, you can perform an "OR" operation on two integers that is a logical OR on their bit representations, and you can test bits, shift bits, and swap bytes in 16- and 8-bit variables. There are also built-in primitives for handling interrupts at the Pascal level. The programmer can enable and disable interrupts and designate up to seven Pascal proce-

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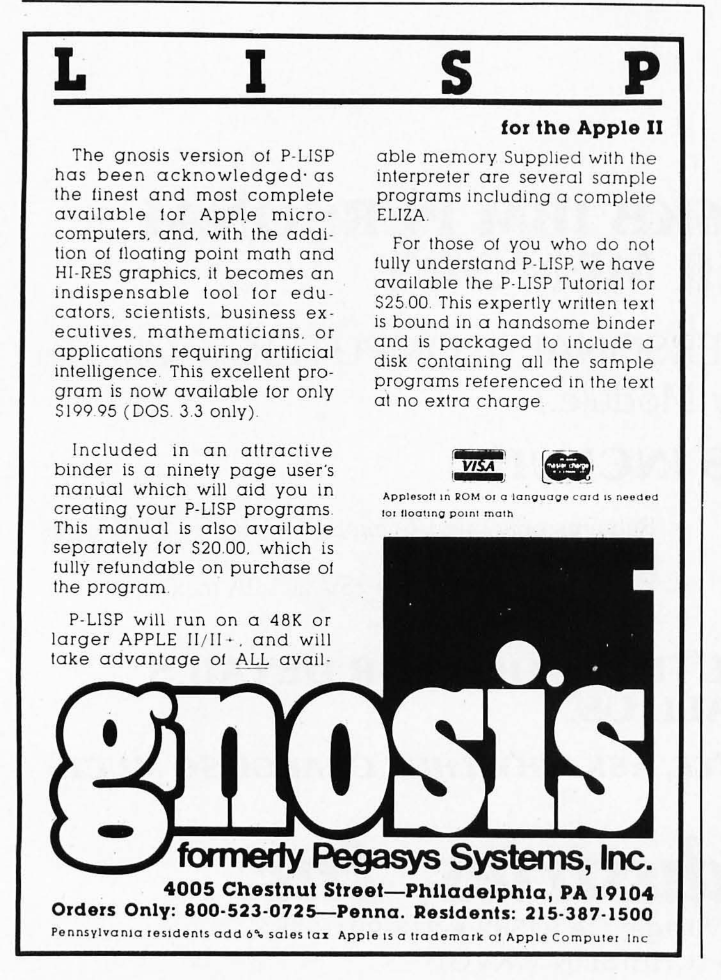
dures as interrupt procedures. The programmer assigns a vector number to an interrupt procedure and the compiler generates code to load the vector number with the procedure address.

Only Pascal/Z permits functions to return structured data values. In the other Pascals, functions can return only unstructured types.

Input-Output Procedures

Not surprisingly, there is significant variation in the I/O procedures that these four Pascals provide. The versions differ in adherence to standard Pascal and in their extensions to the standard.

Standard Pascal specifies four primitive file-handling procedures—GET(F), PUT(F), RESET(F), and REWRITE(F), where F is an arbitrary file type—and certain procedures for reading and writing text files. PUT(F) appends data to F, GET advances the file-position pointer and retrieves the next record, RESET resets the file-position pointer to the beginning of the file, and REWRITE initializes a file for writing. The text-file procedures are READ and READLN, which reads to the end of a line, and their counterparts WRITE and WRITELN. Left to the Pascal implementer is the way that an external disk file is associated with the internal file. Standard Pascal makes no provision for random access I/O.



Pascal/MT+, Pascal/M, and UCSD Pascal all supply the standard procedures; Pascal/Z subsumes the operations of GET and PUT under general-purpose READ and WRITE procedures. All four Pascals have simple methods for assigning disk files and external devices to internal file variables. All versions provide some form of random access for nontext files.

All four versions have built-in facilities for purging files from disk directories. All but Pascal/Z have an added procedure for closing an open file; in Pascal/Z, files are automatically closed on exit from the procedure block in which the file is declared, but there is no way to close a file explicitly.

Pascal/M, Pascal/MT+, and UCSD Pascal all provide a built-in function IORESULT that returns an integer value to indicate the result of the last I/O operation. The function can trap fatal execution-time I/O errors, such as failure to find a required disk file.

UCSD Pascal, Pascal/M, and Pascal/MT+ all provide low-level procedures to perform I/O on *untyped files.* These procedures transfer memory-image bytes with no interpretation. In addition, Pascal/M and Pascal/MT+ provide built-in primitives for manipulating Z80 input-output ports.

Modules, Overlays and Chaining

Programmers developing large application programs face several problems that can become acute on microcomputers. Among these are limitations on memory size, the time-consuming need to recompile large programs when only small changes are made, and the need to link high-level programs to low-level routines for speed or convenience in special applications. The four Pascals reviewed here are reasonably well equipped with tools to solve these problems.

Two techniques for mitigating limitations on memory size are overlays (program segmentation) and chaining (calling one program from another). For the overlay approach, the programmer declares segments within a host program, with the segments either procedures or functions. A segment is brought into memory from disk when needed and remains active in memory only as long as needed; control returns to the host program. Segment procedures can access global data and procedures in the host program, just as they do ordinary procedures. With chaining, the currently active program calls the next link in the chain, which is then loaded from disk. There need be no host program per se and no relationship between the global declarations of chained programs.

UCSD Pascal and Pascal/M support overlays. In UCSD Pascal, a program can have a maximum of 16 segments, while Pascal/M can support as many as 10 segments. Both versions count the host program as one segment. Pascal/Z and Pascal/MT+ allow chaining. Both provide mechanisms for sharing global data between chained programs, but not for sharing global procedures. Pascal/Z, UCSD Pascal, and Pascal/MT+ support the ability to divide large programs into separately compil-



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able pieces and the concomitant ability to develop modules or libraries of logically related procedures.

UCSD Pascal offers UNITs, which consist of three major syntactical pieces: an INTERFACE portion, an IMPLEMENTATION portion, and initialization code. The INTERFACE portion contains the declarations (data, procedures, and functions) accessible to a host program. The IMPLEMENTATION portion contains the code for the procedures delcared in the INTERFACE and any additional data structures and code required to perform the tasks of the unit; the latter declarations are not accessible to the host program. The initialization code is used to initialize the UNIT and is unknown to the host.

UCSD UNITs come in two varieties: intrinsic UNITs and regular UNITs. An intrinsic UNIT must be stored in the system library, which must be online when a program using the unit is executed. Intrinsic UNITs are prelinked to their hosts and do not have to be relinked if either the host or the UNIT is changed. Regular UNITs must be linked to the host by the programmer. Once linked, they need not be online, since the UNIT's code is duplicated in the host's code file. Regular UNITs count against the number of segments allowed in a program; intrinsic UNITs do not.

Pascal/MT+ provides what it calls modular compilation. When combined with a certain compiler option, this feature is comparable to the UCSD regular UNIT except for the initialization code. Pascal/MT+ modules may be somewhat more convenient to use than UCSD UNITs because the former can be broken into as many modules as desired at any time, while the latter require more forethought for effective use.

Pascal/Z provides a somewhat more limited version of modular compilation than Pascal/MT+. First, the number of modules is held to 10, including the host program. Also, there can be no hidden portions to a Pascal/Z module; in the language of UCSD UNITs, Pascal/Z modules consist of only an INTERFACE block. Finally, a Pascal/Z module cannot contain any global data declarations; it can only contain procedures and functions with local (private) data structures.

Like UCSD UNITs, Pascal/Z and Pascal/MT+ modules must be linked explicitly to their hosts. Unlike UCSD Pascal, Pascal/Z and Pascal/MT+ make the programmer responsible for insuring that data and procedures used by the host and its modules are declared consistently across modules.

Modules in Pascal/Z and Pascal/MT+ can freely use procedures declared in other modules. Procedures can be similarly cross-referenced by UCSD UNITs, but this requires more planning than in the other two Pascals.

Pascal/Z, Pascal/MT+ and UCSD Pascal all allow the user to link Z80 assembly-language programs to Pascal programs. Pascal/MT+ features a special declaration INLINE whereby the programmer can include hexadecimal code for machine-language programs in the body of a Pascal program without using externally assembled routines.

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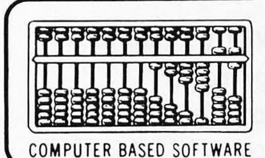
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Ease of Use

Ease of use of any given language implementation lies mainly with the user. Ease of use may be defined as a measure of how quickly and reliably an implementation can help a programmer accomplish a given programming task.

The main advantage of Pascal is the ease with which the programmer can express the control and data structures that seem to arise naturally when designing a program. Beyond the standard Pascal, however, there is much that the language implementer can do to simplify the programmer's job. Since the programmer spends (or should spend) a great deal of time designing and writing programs, the relevant question is whether the language implementation helps or hinders the programming process. String functions, for example, have proved very useful in manipulating character data of arbitrary length, and all the Pascals we examined had string functions in one form or another. We feel that other additions to standard Pascal can be of great help, as long as they do not detract too much from the resulting program's portability to other systems. We previously discussed most of these useful features.

In addition to programming ease, there is debugging ease that reduces the time necessary for the programmer to sit in front of the video display. The sequence of commands that the user types to compile, link, and run a program can be simple (e.g., with UCSD Pascal, in the simplest case, you can execute a source program just by typing an "R") or complex (e.g., Pascal/Z, which in the simplest case requires three separate CP/M commands to transform a source file into a runnable program). Fortunately, CP/M commands can themselves be gathered into a file and executed using the SUBMIT feature.

Finally, the documentation can be a source of either help or frustration. The manuals that accompany these packages are uniformly poor; unfortunately, they were probably written by the programmers who developed the packages. Any user who expects to learn Pascal from these will be bitterly disappointed. (Although to be fair, the manuals do not claim to be tutorials.) We also found the manuals disorganized, with poor indexes and tables of contents. Finding the answer to any specific question was a challenge, and the clarity of the English in the documentation is best left without critique.

We mentioned earlier that UCSD Pascal comprises an entire operating system, but failed to express the grief we experienced in getting the system configured for our machine, compounded by the confusing and contradictory documentation. The configuration process per se is simple. The difficulty is in reaching the point at which you can start the configuration process.

We point this out not to dissuade the reader from using UCSD Pascal, but to inform you of what to expect. If you are interested in UCSD Pascal, it may be worthwhile to seek out a configuration matched to your machine. Some preconfigured versions are available.

Benchmarks

To test each version of Pascal for speed, ease of use, and other features, we wrote and ran a series of benchmark programs. We did all testing on a Cromemco System III computer, which has 64K bytes of memory and two 8-inch floppy-disk drives capable of handling more than a million bytes of data each. The CP/M-compatible versions of Pascal were run under CP/M version 2.2 (from Intelligent Terminals Corporation). We timed the programs using Mountain Computer's 100,000 Day Clock. The results appear in table 1.

A few words of caution: the results of these (or any other) benchmarks should not be taken as absolute indicators of any Pascal's inherent quality. Our programs are necessarily simple and relatively portable between the different implementations. We certainly do not represent these programs as the "best" programming solutions available for the problems they solve.

Our first benchmark, PRIMES (see listing 1), is a program to calculate the first 1000 prime numbers, using a method from Donald Knuth's *The Art of Computer Programming, Volume I: Fundamental Algorithms* (Reading, MA: Addison-Wesley, 1968), pages 143-144. The only statements that needed change, as we moved from one version of Pascal to the next, were in the routine to read the time from the Mountain Computer clock board, which required Z80 hardware port input. Pascal/M and Pascal/MT+ had intrinsic routines to do such input; for UCSD Pascal and Pascal/Z, we wrote small assembler routines to do the job. To minimize rewriting, we isolated the version-dependent code in a function that was different for each implementation.

We also made two ease-of-use measurements while we were compiling and running the program. First, we measured the time needed to transform the Pascal source file into a running program. For the CP/M Pascals, we used a SUBMIT file containing the necessary commands

Language Implementation Program	Pascal/M	Pascal/MT+	Pascal/Z	UCSD Pascal
PRIMES				
Execution time	94.2 sec	24.1 sec	35.1 sec	70.0 sec
"Compile time"	35 sec	93 sec	132 sec	46 sec
Keystrokes required to run	31	56	68	16
PRECISION				
Small	5.96E−08	1.19E−07	2.38E−07	5.96E−08
Big	3.36E+07	1.68E+07	8.39E+06	3.36E+07
BLOWUP				
Memory available for dynamic variables	37.4 K	52.3 K	52.4 K	38.9 K
BENCHMARK (All numbers are execution times in seconds)				
Random number generation	3.4	2.7	1.1	2.0
Writing array to disk	3.5	4.3	3.9	6.9
Shell sort	332	152	93	193
Reading array from disk	1.4	2.0	1.8	2.4
Quicksort	31	14	15	18
Binary tree generation	51	21	8	25
Writing tree to disk	28	25	21	45
Displaying array on CRT	46	10	14	22
Displaying tree on CRT	48	11	14	23

Table 1: *Results of benchmarking programs for four implementations of Pascal. All testing was done on a Cromemco System III computer with two 8-inch disk drives. PRIMES, shown in listing 1, is a program that calculates the first 1000 prime numbers. PRECISION, shown in listing 2, determines the precision of floating-point calculations in each implementation of Pascal. BLOWUP, shown in listing 3, determines the approximate amount of memory space available for dynamically allocated variables. BENCHMARK, shown in listing 4, performs a series of tasks common in applications programs.*

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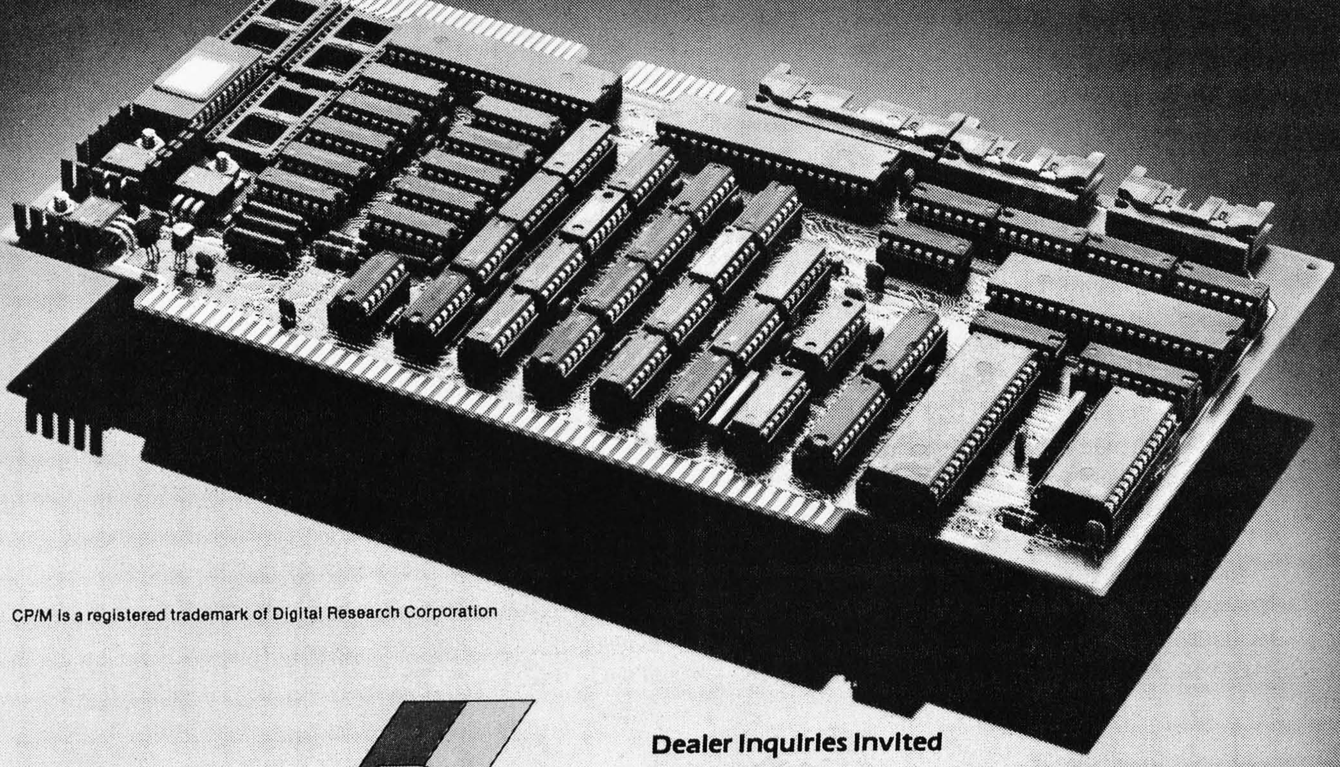
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Listing 1: *PRIMES, a Pascal program that calculates the first 1000 prime numbers, based on an algorithm from Donald Knuth's* The Art of Computer Programming, Volume I: Fundamental Algorithms.

```
PROGRAM primes;
CONST
 maxvec=14; (* used by the timing routine *)
 np=1000; (* number of primes *)
TYPE
 timevec=ARRAY[0..maxvec] OF INTEGER;
VAR
 junk,lapse:REAL;
 t:timevec;
 pr:ARRAY [1..np] OF INTEGER;
 j,k,n,q,r:INTEGER;

 FUNCTION portin(port:INTEGER):INTEGER; (* Pascal-M version *)
 VAR
  i:INTEGER;
 BEGIN
  inport(port,i);
  portin:=i;
 END;

 FUNCTION tick(VAR t:timevec):REAL;
 CONST
  baseport=32;
 VAR
  i:INTEGER;
  prev:timevec;
 BEGIN
  FOR i:=0 TO maxvec DO
   prev[i]:=t[i];
  FOR i:=0 TO maxvec DO
   t[i]:=portin(baseport+i);
  tick:=0.0001*(t[ 0]-prev[ 0])+ (* 100 microseconds *)
         0.001*(t[ 1]-prev[ 1])+ (* milliseconds *)
          0.01*(t[ 2]-prev[ 2])+ (* 10 milliseconds *)
           0.1*(t[ 3]-prev[ 3])+ (* 100 milliseconds *)
           1.0*(t[ 4]-prev[ 4])+ (* seconds *)
          10.0*(t[ 5]-prev[ 5])+ (* 10 seconds *)
          60.0*(t[ 6]-prev[ 6])+ (* minutes *)
         600.0*(t[ 7]-prev[ 7])+ (* 10 minutes *)
        3600.0*(t[ 8]-prev[ 8])+ (* hours *)
       36000.0*(t[ 9]-prev[ 9])+ (* 10 hours *)
       86400.0*(t[10]-prev[10])+ (* days *)
      864000.0*(t[11]-prev[11])+ (* 10 days *)
     8640000.0*(t[12]-prev[12])+ (* 100 days *)
    86400000.0*(t[13]-prev[13])+ (* 1000 days *)
   864000000.0*(t[14]-prev[14])+ (* 1000 days *)
 END;

BEGIN
 writeln('The first ',np,' primes:');
 junk:=tick(t);
 pr[1]:=2;
 pr[2]:=3;
```

Listing 1 continued on page 338

Listing 1 continued:

```
  n:=3;
  j:=2;
  REPEAT
   REPEAT
    n:=n+2;
    k:=1;
    REPEAT
     k:=k+1;
     q:=n DIV pr[k];
     r:=n-q*pr[k];
    UNTIL (q<pr[k]) OR (r=0);
   UNTIL r<>0;
   j:=j+1;
   pr[j]:=n;
  UNTIL j=np;
  lapse:=tick(t);
  FOR j:=1 TO np DO
   writeln('Prime(',j,')= ',pr[j]);
  writeln('The calculation took ',lapse,' seconds.');
 END.
```

to eliminate variation due to typing speed. We started timing when the compilation of the program began and stopped when the program's message "The first 1000 primes:" was displayed. Then we counted the number of keystrokes that would have been necessary for compilation.

As expected, we found that the execution time of programs produced by the native-code compilers was much less than that of programs produced by the P-code compilers. On the other hand, the compilation time and the number of keystrokes necessary to run the program were much greater for the native-code compilers; there is a trade-off between calculational speed and ease of use. Perhaps the ideal situation would have P-code used for software development and native code employed for the final version.

Our second benchmark is PRECISION (see listing 2). It is an attempt to determine the precision of floating-point calculation for each Pascal. We calculated two numbers, BIG and SMALL. BIG was defined to be the largest number such that:

$$(BIG + 1.0) > BIG$$

given the limitations of floating-point arithmetic. Similarly, SMALL was defined to be the smallest number such that:

$$(1.0 + SMALL) > 1.0$$

Here we found that all our Pascals had approximately seven digits of precision, some slightly more and others slightly less. (Note that all four verions include some means of doing extended-precision arithmetic.)

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Listing 2: *PRECISION, a program that determines the precision of floating-point calculations for each Pascal.*

```
PROGRAM precision;
VAR
 small,big,factor,test:REAL;
BEGIN
 small:=1.0;
 factor:=3.0;
 WHILE factor>(1.0+small) DO
  BEGIN
   test:=small/factor;
   WHILE ((test+1.0)>1.0) AND (test<small) DO
    BEGIN
     small:=test;
     test:=test/factor;
    END;
    factor:=(1.0+factor)/2.0;
  END;
 writeln('Small= ',small);

 big:=1.0;
 factor:=3.0;
 WHILE factor>(1.0+small) DO
  BEGIN
   test:=big*factor;
   WHILE ((test+1.0)>test) AND (big<test) DO
    BEGIN
     big:=test;
     test:=test*factor;
    END;
   factor:=(1.0+factor)/2.0;
  END;
 writeln('Big= ',big);
END.
```

Our third benchmark, BLOWUP (see listing 3), was designed to measure the amount of memory each implementation had available for dynamically allocated variables. The program successively allocates 100-byte blocks of memory until a run-time error occurs due to lack of additional memory. The program continuously prints out the number of blocks it has successfully allocated; the last number it prints (before the run-time error), divided by 10, is the approximate dynamic-memory space in kilobytes. All the versions of Pascal except for Pascal/MT+ generated such an error; running the program with Pascal/MT+ eventually caused the system to "hang," apparently due to overwriting the memory containing the program or the operating system. Pascal/MT+ does not check for such memory overflow; the programmer must do it with one of the built-in procedures. (For many programmers, this may be a desirable feature.)

From this program we found that the native-code compilers have more space for program code and dynamic variables than do the P-code versions. This is probably because of the extra memory required for the P-code interpreters, which results in less memory available to user programs. This test is somewhat misleading, however, since for larger programs this situation could be reversed. P-code should be more compact than native code, and the compactness should atone for the interpreter overhead in large programs. (We did not test this hypothesis.)

The final benchmark is called BENCHMARK (see listing 4), which is an attempt to measure the different Pascals' performances in the more realistic applications of sorting, disk I/O, and data-structure generation. The program first generates a pseudorandom array of 1024 integers, then writes it to disk. (Pascal allows writing the entire array as a single entity, which turns out to be infinitely faster on our system than writing each element of the array individually.) The array is sorted using the Shell-Metzner algorithm. The random array is then read back into memory from disk (again, as a single entity) and sorted using the quicksort algorithm. (Both sorting algorithms are adapted from *Algorithms Plus Data Struc-*

Text continued on page 352

ton's picture on them. Watch for Granny!

Listing 3: *BLOWUP, a program that measures the amount of memory available for dynamically allocated variables. The program successively allocates 100-byte blocks of memory until a run-time error occurs.*

```
PROGRAM blowup;
CONST
  blocksize=100;
TYPE
  byte=0..255;
  block=PACKED ARRAY[1..blocksize] OF byte;
  blockptr=^block;
VAR
  p:blockptr;
  i,j:INTEGER;
BEGIN
  i:=0;
  WHILE TRUE DO
   BEGIN
    new(p);
    FOR j:=1 TO blocksize DO
     p^[j]:=0;
    i:=i+1;
    writeln(i);
   END;
END.
```

Listing 4: *BENCHMARK, a program that measures performance in tasks that occur commonly in applications programs. The program generates a random array of integers; writes the array to disk; sorts the array with the Shell-Metzner algorithm; reads the random array back into memory from disk; sorts the array with the quicksort algorithm; reads the unsorted array into memory yet again, using the integers as keys by which dummy data are stored in a binary tree; and writes the tree elements individually to disk. Along the way, the program displays the array elements on the terminal screen to insure that the disk input/output and the sorts are done correctly, as well as to see how fast each version of Pascal can output text.*

```
PROGRAM benchmarks;

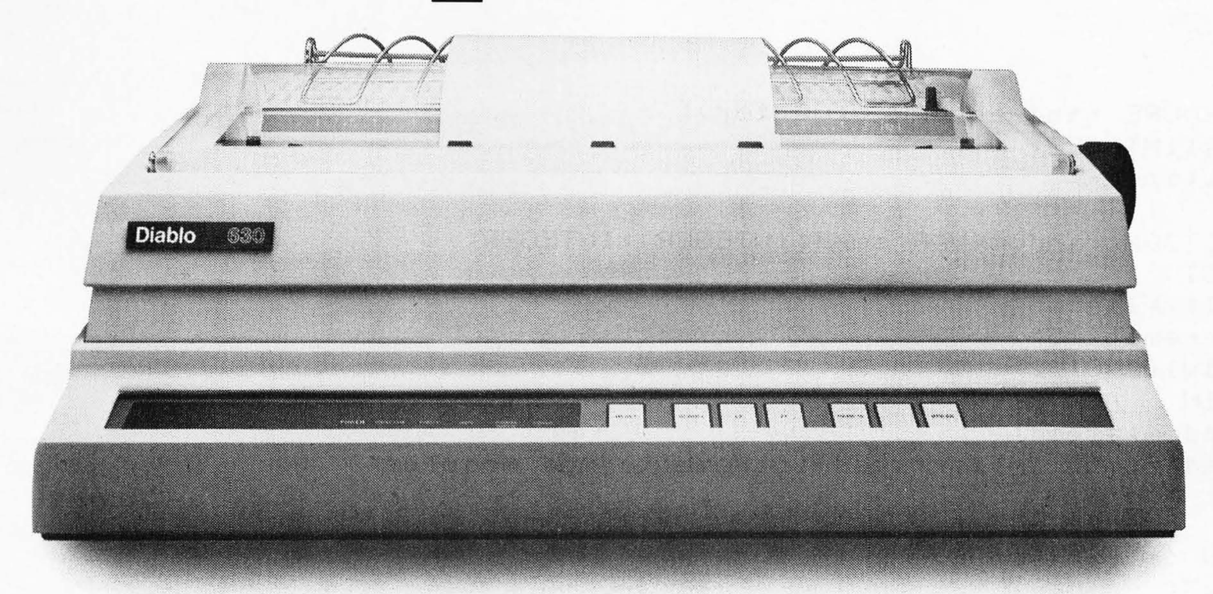
CONST
 maxlength=1024;
 maxvec=14;  (* part of timing package *)

TYPE
 index=0..maxlength;
 vector=ARRAY[index] of INTEGER;
 link=^node;
 dummydata=RECORD
            key:INTEGER;
            frequency:index;
            datafield:STRING[16];
           END;
 node=RECORD
       dd:dummydata;
       left,right:link;
      END;
 timevec=ARRAY[0..maxvec] OF INTEGER; part of timing package

VAR
 v:vector;
 root:link;
 nodecount:INTEGER;
```

Listing 4 continued on page 344

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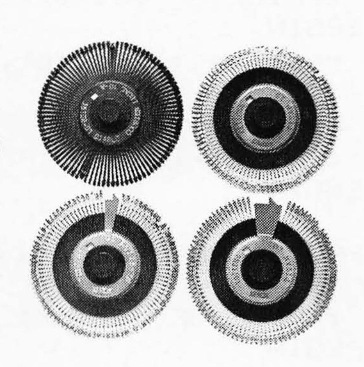
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Listing 4 continued:

```
junk:REAL; part of timing package
t:timevec

(* define 'portin' and 'tick' as in PROGRAM primes; *)

FUNCTION portin(port:INTEGER):INTEGER;
BEGIN
...
...
END;

FUNCTION tick(VAR t:timevec):REAL;
BEGIN
...
...
END;


PROCEDURE randgen(VAR v:vector);
VAR s:INTEGER;
     i:index;

 FUNCTION random(VAR seed:INTEGER):INTEGER;
 CONST
  multiplier=3;
  increment=5;
  modulus=8192;
 BEGIN
  random:=seed;
  seed:=(multiplier*seed+increment) mod modulus;
 END;

BEGIN (* randgen *)
  s:=3;
  FOR i:=1 TO maxlength DO
   v[i]:=random(s);
END;

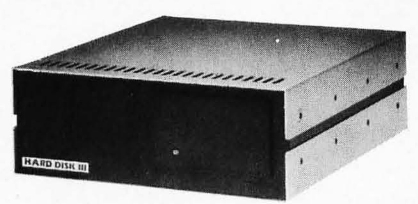
PROCEDURE writearray(VAR v:vector);
VAR
 f:FILE OF vector;
BEGIN
 rewrite(f,'vector.dat');
 f^:=v;
 put(f);
 close(f,lock);
END;

PROCEDURE readarray(VAR v:vector);
VAR
 f:FILE OF vector;
BEGIN
 reset(f,'vector.dat');
 get(f);
 v:=f^;
END;
```

Listing 4 continued on page 346

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Listing 4 continued:

```
PROCEDURE shellsort(VAR v:vector);
VAR jump,m,n:index;
     temp:INTEGER;
     done:BOOLEAN;
BEGIN
 jump:=maxlength;
 WHILE jump>1 DO
  BEGIN
   jump:=jump DIV 2;
   REPEAT
    done:=TRUE;
    FOR m:=1 TO (maxlength-jump) DO
     BEGIN
      n:=m+jump;
      IF v[m]>v[n] THEN
       BEGIN
        temp:=v[m];
        v[m]:=v[n];
        v[n]:=temp;
        done:=FALSE;
       END;
     END;(* FOR *)
   UNTIL done;
  END; (* WHILE *)
END; (* shellsort *)

PROCEDURE quicksort(VAR v:vector);

 PROCEDURE sort(left,right:index);
 VAR i,j:index;
     pivot,temp:INTEGER;
 BEGIN

   i:=left;j:=right;
   pivot:=v[(left+right) DIV 2];
   REPEAT
    WHILE v[i]<pivot DO i:=i+1;
    WHILE pivot<v[j] DO j:=j-1;
    IF i<=j THEN
     BEGIN
      temp:=v[i];
      v[i]:=v[j];
      v[j]:=temp;
      i:=i+1;
      j:=j-1;
     END;
   UNTIL i>j;
   IF left<j THEN sort(left,j);
   IF i<right THEN sort(i,right);
 END;

BEGIN
 sort(1,maxlength);
END;
```

Listing 4 continued on page 348

Listing 4 continued:

```
PROCEDURE treegen(VAR root:link;VAR v:vector);
VAR
 nodecount:INTEGER;
 i:index;

 PROCEDURE insert(VAR ref:link;VAR nodecount:INTEGER;newkey:INTEGER);
 BEGIN
  IF ref=nil THEN
   BEGIN
    new(ref);
    nodecount:=nodecount+1;
    WITH ref^ DO
     BEGIN
      left:=nil;
      right:=nil;
      WITH dd DO
       BEGIN
        datafield:='0123456789ABCDEF';
        key:=newkey;
        frequency:=1;
       END;
     END;
   END
   ELSE WITH ref^ DO
    IF newkey<dd.key THEN insert(left,nodecount,newkey)
     ELSE IF newkey>dd.key THEN insert(right,nodecount,newkey)
     ELSE (*duplicate key! update frequency.*)
          dd.frequency:=dd.frequency+1;
 END;

BEGIN
 root:=nil;
 nodecount:=0;
 i:=0;
 REPEAT
  i:=i+1;
  insert(root,nodecount,v[i]);
 UNTIL i=maxlength;
 writeln(nodecount,' distinct nodes created.');
END;

PROCEDURE writetree(root:link);
VAR
 dummyfile:FILE OF dummydata;
 counter:INTEGER;

 PROCEDURE traverse(ref:link;VAR counter:INTEGER);
 BEGIN
  IF ref<>nil THEN
   BEGIN
    traverse(ref^.left,counter);
    dummyfile^:=ref^.dd;
    put(dummyfile);
```

Listing 4 continued on page 350

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```
      counter:=counter+1;
      traverse(ref^.right,counter);
    END;
  END;

 BEGIN
  rewrite(dummyfile,'dummy.dat');
  counter:=0;
  traverse(root,counter);
  close(dummyfile,lock);
  writeln(counter,' records written.');
 END;

 PROCEDURE disparray(VAR v:vector);
 VAR
  i:index;
 BEGIN
  FOR i:=1 TO maxlength DO writeln(v[i]);
 END;

 PROCEDURE disptree(ptr:link);
 BEGIN
  IF ptr<>nil THEN BEGIN
   disptree(ptr^.left);
   writeln(ptr^.dd.key);
   disptree(ptr^.left);
  END;
 END;

BEGIN
 junk:=tick(t);

 randgen(v);
 writeln('Random array generation took ',tick(t),' sec.');

 disparray(v);
 writeln('Displaying array took ',tick(t),' sec.');

 writearray(v);
 writeln('Writing array to disk took ',tick(t),' sec.');

 shellsort(v);
 writeln('Shell sort took ',tick(t),' sec.');

 disparray(v);
 writeln('Displaying array took ',tick(t),' sec.');

 readarray(v);
 writeln('Reading array from disk took ',tick(t),' sec.');

 disparray(v);
 writeln('Displaying array took ',tick(t),' sec.');

 quicksort(v);
 writeln('Quicksort took ',tick(t),' sec.');
```

Listing 4 continued on page 352

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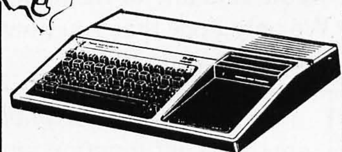


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Listing 4 continued:

```
  disparray(v);
  writeln('Displaying array took ',tick(t),' sec.');

  readarray(v);
  writeln('Reading array from disk took ',tick(t),' sec.');

  disparray(v);
  writeln('Displaying array took ',tick(t),' sec.');

  treegen(root,v);
  writeln('Generating binary tree took ',tick(t),' sec.');

  disptree(root);
  writeln('Displaying tree took ',tick(t),' sec.');

  writetree(root);
  writeln('Writing tree to disk took ',tick(t),' sec.');
END.
```

Text continued from page 340:

tures Equals Programs by Niklaus Wirth, Prentice-Hall, 1975.) After this, the unsorted array is again read into memory, and the integers are used as keys by which dummy data are stored in a binary tree. The tree elements are then written individually to disk. The array elements are displayed on the monitor along the way to insure that the disk I/O and the sorting are done correctly. Displaying the array also measures how fast the Pascal can output textual information.

The incompatibilities between the Pascal implementations for this program only involved the way the disk data were accessed. Slight changes in the program were made for opening, closing, reading, and writing to the disk files. (Obviously, the changes described for reading the clock also had to be made.)

Again, native-code compilers were faster in the computation-intensive tasks such as sorting and were also noticeably faster in output to the terminal. All Pascals took about the same time to write and read from the disk.

The four Pascals reviewed here defy classification as good or bad; they seem almost to represent different philosophies of language implementation. We cannot recommend one Pascal over another or say that you would find any of them unacceptable for your purposes. We only hope that you now have enough information to decide for yourself.■

Updates seem to be published faster than magazines are. Some information on new versions of the Pascals tested in this article is given on page 356. . . . G.W.

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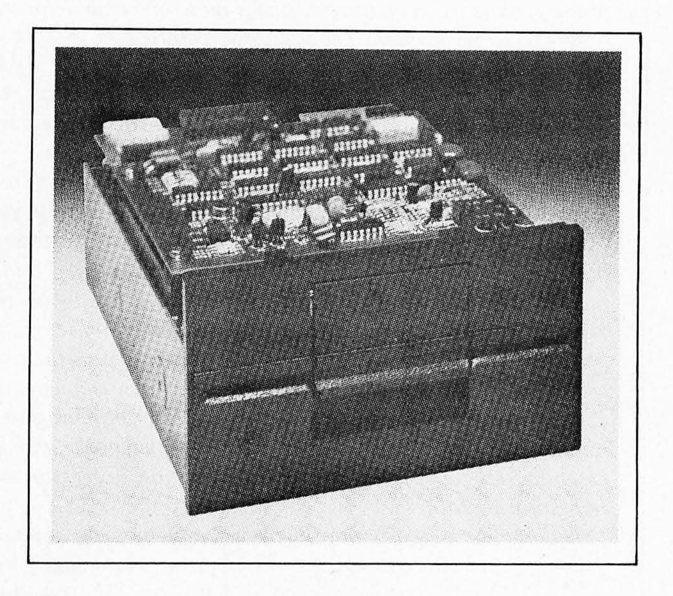
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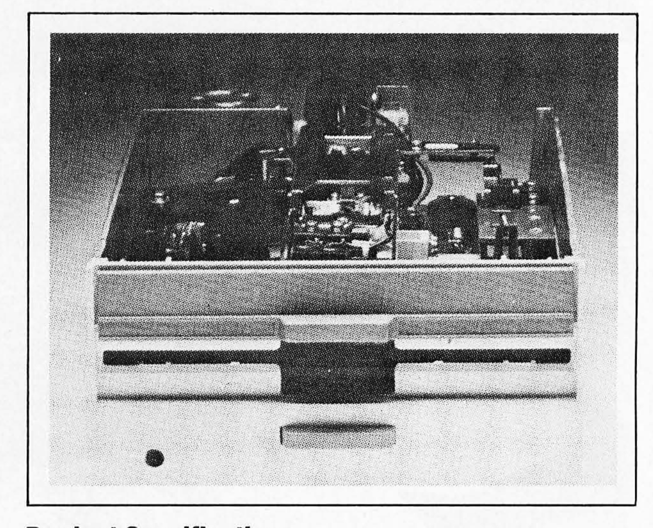
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Programming Language Terms

Machine language, *also called* object code, *is binary; it consists entirely of zeros and ones. Words made of zeros and ones represent both* op codes, *which define basic operations in the processor, and addresses of the data on which an operation is to be performed. The accurate reading and writing of machine language is difficult.*

Machine-language statements that use the correct op *codes for a specific processor are said to be the* native code *for that processor.*

Intermediate between machine language and higher-level languages like Pascal is assembly language. *Assembly language substitutes standard mnemonics—more easily remembered names—for machine-language instructions. Statements in assembly language are not directly executable. An* assembler *is a program that translates assembly-language code into machine code; a* macro assembler *allows the programmer to use a single name to represent a sequence of assembly-language instructions. Assembly-language mnemonics vary from one processor to the next, and an assembly-language program written for one processor will not run on another.*

A compiler *is a program that translates the programmer's statement in a* source language *or* higher-level language *(such as BASIC or Pascal) into machine language. The resulting machine-language code needs no support software to run (except an operating system). Compilers process an entire program at one time; the resulting machine-language code can be executed only after the whole program is compiled.*

Single-pass *compilers complete the translation of a program in source language into machine language in a single, continuous operation.* Multiple-pass *compilers divide the process of translation into different stages. The advantage of multiple-pass compilers is that they usually reduce demands on main memory, though single-pass compilers work faster.*

An interpreter *is a program that translates each source-language statement into machine language as the statement is read and then immediately executes the machine-language translation of the statement.*

Some higher-level language implementations such as CBASIC (from Compiler Systems) and Pascal/M compromise between the compiler approach and the interpreter approach. These implementations compile source code into a nonexecutable intermediate code; *a separate interpreter must then be run to execute the intermediate code. The intermediate code produced by a Pascal compiler is called* P-code. *Unlike assembly language, P-code is the same for different versions of Pascal that use the intermediate-code approach.*

A linker *is a program that combines into a single module two or more program segments that have been separately compiled.*

A program library *is a set of programs distributed with a program language to provide code to perform frequently used operations. Programmers save time and labor by incorporating code from the library in programs under development. A linker can incorporate library program segments into a program whose other segments were written by an applications programmer and separately compiled.*

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Pascal Updates

Each Pascal has been revised and improved in the past few months. All of the vendors claim bug fixes, increased speed for low-level support routines, and better user interfaces. We were unable to test the new versions. Version numbers and prices were current as of October 1981.

Pascal/Z Version 4.0

An interactive debugger and the ability to segment programs are the major additions to Pascal/Z. The debugger is fully symbolic. Among other things, you can symbolically display and modify local and global variables (including record fields), trace program flow, and display run-time memory requirements.

Overlays, or segments, are compiled separately like modules. They are then processed by a system program that prepares the memory maps and relocation information needed by a host that uses the overlay. Finally, they are linked to the host.

Version 4.0 costs $395. The cost of updating from Version 3.3 is $50; new manuals are included in the update.

Pascal/M Version 4.02

Major enhancements to Pascal/M are an interactive symbolic debugger, the ability to perform 14-digit BCD arithmetic, and an increase from 10 to 40 in the number of program segments permitted.

Pascal/MT+ Version 5.5

Several changes have been made to Pascal/MT+ to increase its power and compatibility with other CP/M software. The compiler has been reduced in size by 7K bytes, substantially adding to the amount of symbol table space for compiling user programs. Users can compile larger programs than were heretofore possible.

A converter program has been added to the collection of utility programs. The new program converts code files produced by the compiler to a format acceptable to Microsoft linkers. Overlays are now allowed. A program is permitted 16 overlay "areas" with up to 16 overlays per area. The programmer is burdened with supplying code address information to the linker before the overlays can be used by a host program.

The new version can be purchased with a speed programming kit that consists of a menu-driven program whose options include a screen-oriented character editor, a Pascal syntax scanner for preprocessing program texts, and an identifier frequency counter. The latter can be used, for example, to spot identifiers referenced only once in a program, such as uncalled procedures or unreferenced variables.

The manuals have been rewritten with improved indexes. Version 5.5, including the speed programming kit, is $475.

UCSD Pascal Version 4.0

(Note: Version 3.0 is specially designed for Western Digital's Microengine.)

Major enhancements to UCSD Pascal include an increase in the number of segments and units allowed to 255 and easier compilation and cross-referencing of units, facilitating the development of very large application programs. Programmers can also control the residency of segments and units in memory through calls to intrinsic procedures. Overlay segments can be protected from being overwritten by other segments until the programmer permits, and potentially time-consuming, annoying disk I/O (due to repeated calls to a segment) can be defeated. Chaining is also permitted in Version 4.0.

Procedures for memory management have also been augmented. One of these permits a form of dynamic arrays and should considerably increase the ease of development for libraries of procedures operating on arrays.

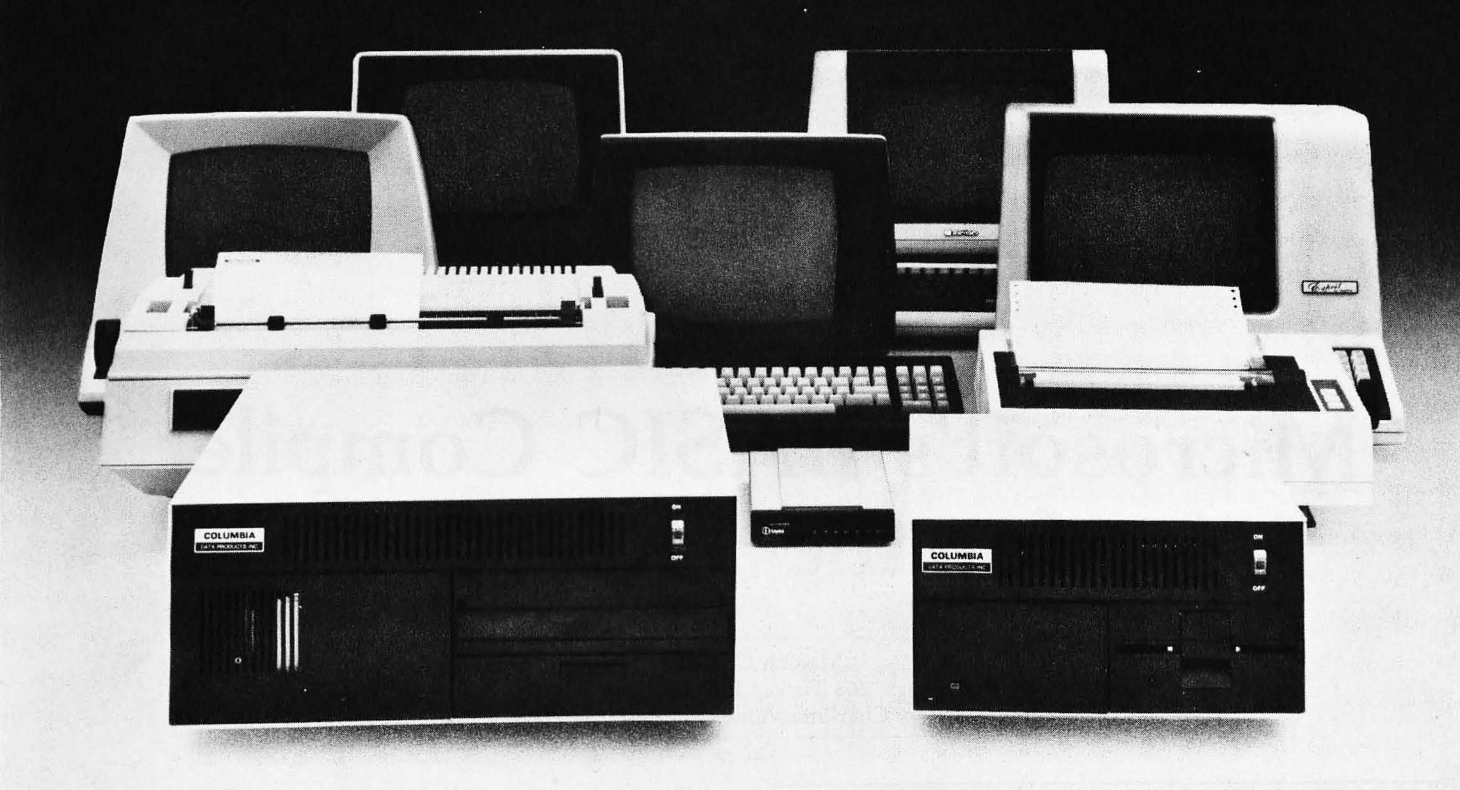
Concurrent processes have been implemented in Version 4.0. Concurrent processes, or tasks, are controlled by "semaphores" (a term coined by E. W. Dijkstra), which synchronize tasks and control access to critical code sections and resources. Semaphores can be associated with hardware interrupts so that interrupt handlers can now be written in UCSD Pascal.

Intrinsic procedures for redirecting program and system I/O have been included. Redirection of system I/O means that the system can be driven from a script in a manner similar to CP/M's SUBMIT facility. Redirection of program I/O enables the programmer to collect the input to (or output from) a program from any peripheral device or disk file.

Additions to the system's utilities include an interactive debugger, a procedural cross-referencer, and a console screen control unit. The documentation has also been completely rewritten.

Version 4.0 costs $500. Preconfigured versions are available for a variety of machines.

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Microsoft's BASIC Compiler for the TRS-80

Mahlon G. Kelly
268 Turkey Ridge Rd.
Charlottesville, VA 22901

At a Glance

Name
BASIC Compiler

Type
A BASIC compiler package, including a compiler, linker, routine library file, and run-time package

Manufacturer
Microsoft Consumer Products
400 108th Ave., Suite 200
Bellevue, WA 98004

Price
Model I, $195

Format
Model I, 5-inch floppy disk; (also available for the TRS-80 Model II)

Language
Z80 machine language

Computer needed
TRS-80 Model I, minimum of 48 K bytes of memory and one disk drive

Documentation
More than 200 pages in a three-ring binder

Audience
TRS-80 BASIC programmers who want to increase the speed of their programs

Do you have friends who tell you that BASIC is a toy language or that it's only for beginners and those too lazy to learn more "sophisticated" languages? Such snobs seem to fall into one of three categories: the machine- or assembly-language fan who wants to commune directly with the hardware and keep track of where every bit goes; the structured-program maven who feels that the machine must force a person to write well-organized programs; and the traditionalist who still thinks that the only "real" higher-level languages are FORTRAN, COBOL, and ALGOL.

Machine and assembly languages are essential when you need fast execution that can't be accomplished with a higher-level language. Structured languages like Ada and Pascal make it much easier to monitor long, convoluted programs.

But we should listen carefully to the traditionalists; they probably learned to program on an IBM 650 in 1956 and have sage minds. Most of them will tell you that FORTRAN, COBOL, and the like are superior because they are compiled languages that use a computer much more efficiently. They forget that BASIC—originally written at Dartmouth College as a simple beginner's language for easy interaction with the computer—is now at least as sophisticated and as easily compiled as older languages.

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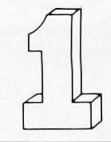
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LIFEBOAT HAS THE ANSWER

Circle 215 on inquiry card.

Listing 1: *A small BASIC program used to demonstrate the compiler.*

```
10   DEFSNG A-Z
20   FOR I=1 TO 2000
30   A=I+2
40   NEXT I
50   PRINT CHR$(7)
```

What It Does

A compiler is a machine-language program that translates a higher-level language, such as FORTRAN or BASIC, into machine code. This compiled program can be stored on disk and run as if originally written in machine language. On the other hand, an interpreter, used in many microcomputers with BASIC, "translates" each line of a program while the program is running. If a line is executed many times, it must be "translated" many times.

A compiled program is therefore much faster than an interpreted one and uses the computer more efficiently despite the lengthy compilation time (which need only be done once). Compilation also allows more flexibility and offers options unavailable with interpretation. Conversely, an interpreted program can be run immediately, without waiting for compilation, and thus is much easier to debug, edit, and modify. Although this may be a poor practice, it is a good way to learn programming and is usually necessary to refine a moderately long program.

Microsoft's BASIC compiler gives you the best of both worlds. It is now possible to debug and modify a program using the TRS-80's built-in interpreter. Then, when it's doing just what you want, it compiles the program to get rapid execution.

I've often wished I could do that with FORTRAN on our university's Cyber 172; in fact, I have been known to write and rewrite a program in interpreted BASIC until it did what I wanted, then translate it "by hand" into FORTRAN for fast execution.

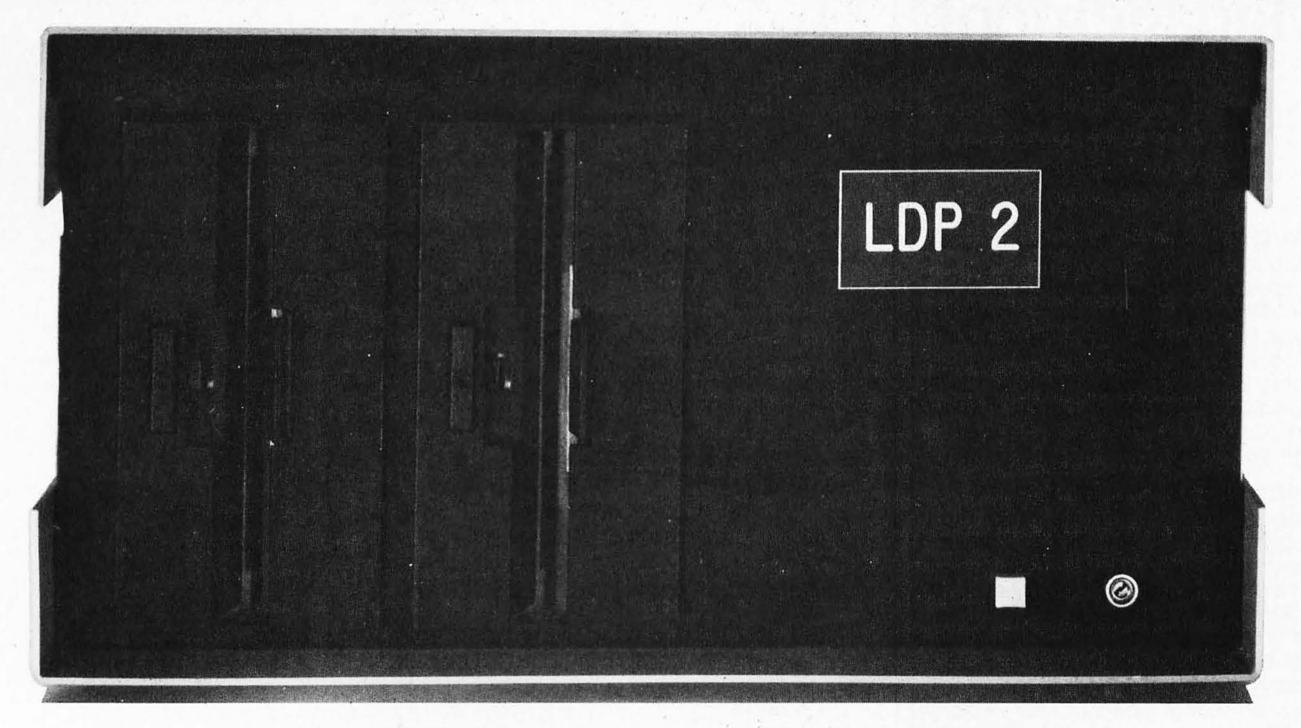
We can evaluate the Microsoft compiler in five ways: ease of use (and quality of documentation); compatibility with TRS-80 disk BASIC; speed; added features compared to interpreted BASIC; and any special quirks, bugs, or problems that may get in the way.

This compiler has many versions; the one I review here is the latest available for the TRS-80. It is much improved over that machine's first version, and anyone with the earlier version can obtain an update from Microsoft for a nominal charge.

Procedures for Use

The compiler is very easy to use, although that's not conveyed in Microsoft's documentation. The compiler is really a package of four software modules: the actual compiler (BASCOM/CMD); a library file (BASLIB/REL); a linker (L80/CMD) that links machine code from the library file to the program as compiled by BASCOM; and a "run-time package" (BRUN/CMD)

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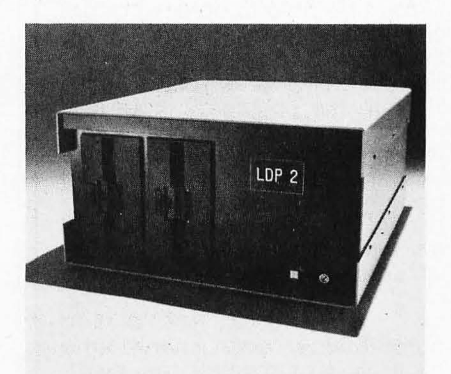
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Listing 2: *The compiled version of the program shown in listing 1.*

```
BASCOM 5.23 - COPYRIGHT 1979, 80 (C) BY MICROSOFT - 08542 BYTES FREE

0014 0007        10 DEFSNG A-Z
         **    0014'          CALL  $4.0
         **    0017'L00010:

0017 0007        20 FOR I=1 TO 2000
         **    0017'L00020:   CALL  $FASA
         **    001A'          DW    I1
         **    001C'          DW    ,CONST.
         **    001E'I00000:

001E 000B        30 A=I+2
         **    001E'L00030:   CALL  $FADA
         **    0021'          DW    I1
         **    0023'          DW    ,CONST.
         **    0025'          CALL  $FASO
         **    0028'          DW    A1

002A 000F        40 NEXT I
         **    002A'L00040:   CALL  $FADA
         **    002D'          DW    I1
         **    002F'          DW    ,CONST.
         **    0031'          CALL  $FASO
         **    0034'          DW    I1
         **    0036'          CALL  $LEJA
         **    0039'          DW    I1
         **    003B'          DW    ,CONST.
         **    003D'          DW    I00000

003F 000F        50 PRINT CHR$ (7)
         **    003F'L00050:   CALL  $PROA
         **    0042'          LD    HL,0007
         **    0045'          CALL  $CHR
         **    0048'          CALL  $PV2D

004B 000F
         **    004B'          CALL  $END

005C 0019

00000 FATAL ERROR(S)

08219 BYTES FREE
```

Listing 3: *The same compiled version of the program, except with two errors inserted to show the response of the compiler.*

```
BASCOM 5.23 - COPYRIGHT 1979, 80 (C) BY MICROSOFT - 13512 BYTES FREE

0014 0007        10 DEFSNG A-Z
         **    0014'          CALL  $4.0
         **    0017'L00010:

0017 0007        20 FOR I=1 TO 2000
         **    0017'L00020:   CALL  $FASA
         **    001A'          DW    I1
         **    001C'          DW    ,CONST.
         **    001E'I00000:

001E 000B        30 A=I+2
         **    001E'L00030:   CALL  $FADA
         **    0021'          DW    I1
         **    0023'          DW    ,CONST.
         **    0025'          CALL  $FASO
         **    0028'          DW    A1

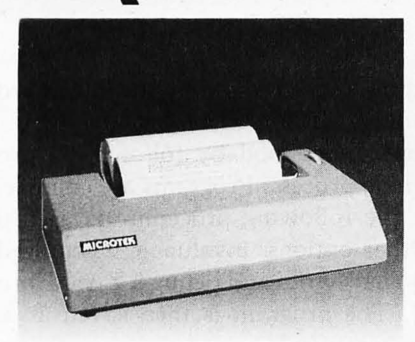
002A 000F        40 NXT I
                              error pointer, syntax error SN
         **    002A'L00040:
```

Listing 3 continued on page 364

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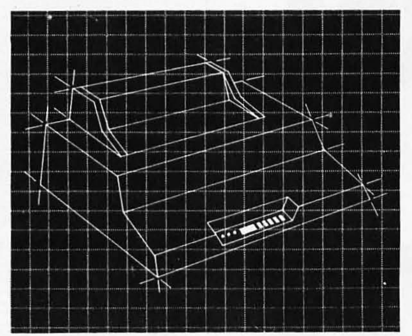
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*Data Source: Epson MX-80 Operation Manual

Parallel $349
Serial $389

TekWriter-2



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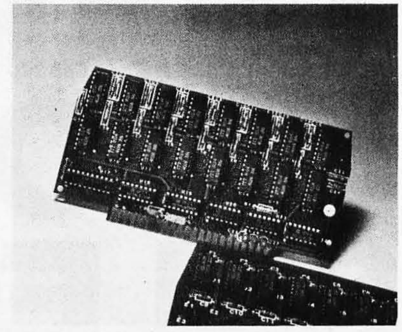
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Tekwriter-2 is especially well suited to handle word processing applications because of its data buffer expansion capabilities to 25K. This ability makes it an efficient graphics generator.

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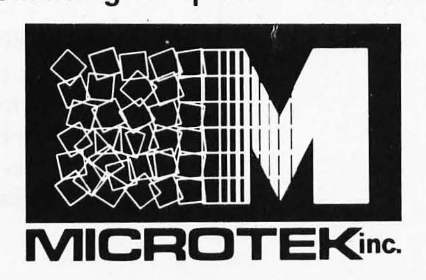
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Listing 3 continued:

```
002A 000F         50 PRINT CHR$(7)
           **     002A'L00050:    CALL  $PROA
           **     002D'           LD    HL,0007
           **     0030'           CALL  $CHR
           **     0033'           CALL  $PV2D
0036 000F
           **     0036'           CALL  $END
                        error pointer, FOR-NEXT error FN

0041 000F

00002 FATAL ERROR(S)

13286 BYTES FREE
```

with additional machine code accessed by the linked program while it is running.

Compilation is best understood by following a program through the whole process. Programs are compiled in many ways, but the following procedure is used in almost all cases. (Other options, invaluable when needed, are rarely used.) First, write and debug a BASIC program (see listing 1). The program is then saved as an ASCII file, using the command:

SAVE "TEST1/BAS",A

(My most common error is forgetting to save it as an ASCII file; also, the BAS extension is needed for recognition by the compiler.) After returning to the DOS with CMD"S", the program is compiled by typing the command:

BASCOM TEST2,TEST3=TEST1

This will produce a listing file (called TEST3/LST) of the compiled code in assembly language (see listing 2) and a partially complete and relocatable machine-language program (called TEST2/REL) that must be linked to other machine code using L80. TEST1/BAS was the BASIC source program.

Error diagnosis is excellent—any errors in the BASIC source code will be listed to the screen and shown in the listing file (see listing 3). The command:

L80 TEST2,TEST4−N−E

will link machine code from BASLIB/REL and produce the file TEST4/CHN (for chain) from TEST2/REL. The "−N" and "−E" are "switches" that in turn tell L80 to write the /CHN file to disk and exit to DOS. A variety of other switches are available for L80 and BASCOM. Again, errors will be listed to the screen. TEST4/CHN can then be run as a machine-language program with the command:

BRUN TEST4

Obviously BRUN/CMD must be available any time the program is run, but the other programs are unnecessary. Other names could have been used for any file, and disk drive numbers could have been specified. Usually, all of the names are the same (e.g., TEST/XXX). In that case, we create files called TEST/BAS, TEST/LST,

TEST/REL, and TEST/CHN. If the compiled program runs correctly, the /LST and /REL files can be deleted.

Although the procedure I describe is used with three disk drives, the sequence is very similar using one or two drives, though disk swapping is necessary. Actually, the process is so cumbersome with one drive that Microsoft doesn't recommend it. (Microsoft also points out that, for almost all purposes, 48 K bytes of memory are needed.) Three double-density drives are ideal. I can use drive 0 for the operating system, drive 1 for the compiler software and Microsoft's FORTRAN and macro assembler, and drive 2 for the various programs.

At this point, the compiler may seem awkward. With practice, it's simple to use and any program needs compilation only once if interactively debugged. Also, the compilation time is very short in relation to the run time if the program is to be run several times. There are some cases, however, when compilation is superfluous. For example, a program that spends most of its time with disk I/O (input/output) will gain little speed by compilation. On the other hand, a program that does a lot of iterative number crunching with little I/O will be greatly quickened. If you use short programs or those that wait a long time for I/O, a compiler won't help much.

	TIMES (seconds)			
	Integer		Single Precision	
	Interpreted	Compiled	Interpreted	Compiled
PRINT(I)	45	18	55	39
A = PEEK(I)	39	2	44	14
A = LEFT$("ABC",1)	37	6	38	9
A! = SIN(3.14159)	149	50	150	50
A = I + 2	40	2	44	8
FORJ = 1TO10:NEXT	169	4	188	8

Table 1: *Execution speeds with the above statements substituted for line 30 in Listing 1.*

Flexibility and Documentation

The compiler is designed to be very flexible; in fact, I can't fully describe its tremendous range of options. For example, subroutines written in Microsoft FORTRAN can be called from BASIC by using the command:

CALL SUBR (A,B,C)

where SUBR is the name of a subroutine in a compiled (but not linked) FORTRAN program and A, B, and C are variables to be passed to the subroutine as sequentially declared in the FORTRAN subroutine statement. You can write a personal subroutine library in FORTRAN that can be called from BASIC. The ability to write a user library of language-independent subroutines is usually found only on mainframe computers or very large minicomputers. Working with the compiler on a microcomputer is much less awkward than it would be on a large computer system. This means, however, that L80 must have a provision for specifying a FORTRAN program that will be searched for subroutines. In other words, flexibility means some complexity in compilation, and there are a wide variety of different procedures for compilation. For example, typing BASCOM and then after a prompt:

TEST2,*PR=TEST1

sends the listing to a line printer. Many other features are too complex and lengthy to be described here.

Unfortunately, this flexibility and complexity mean rather unclear documentation. Microsoft has tried to describe all of the options, special features, and peculiarities of the system before a user becomes acquainted with the rudiments. In some instances, the system's complexity seems to have confused even the writer of the manual.

For example, in one section a COMMON statement is described in great detail, while another section tells us that it's not implemented. In another case, it gives an excellent table comparing Level II BASIC, disk BASIC, and "standard" Microsoft BASIC (BASIC-80) with compiled BASIC, but several statements and commands that are available in compiled BASIC (and BASIC-80) are omitted.

The manual is very complete and includes an introductory section (confusing); a technical section (also confusing) detailing the features of compiled BASIC; and the BASIC-80 manual that gives the syntax of statements not found in either Level II or TRS-80 disk BASIC, but with (distractingly) almost everything in the TRS-80 lan-

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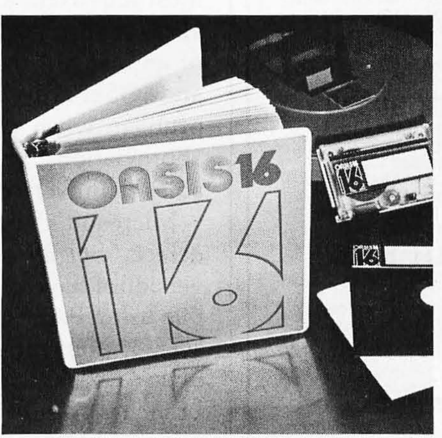
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guages described as well. I spent several days trying to decipher some simple features (like the CALL statement mentioned above), but everything I needed to know was eventually found within the several different sections. The software is easily used, but the simplicity is obscured by very confusing documentation. In fairness to Microsoft, I have seen much worse obfuscation in documentation from CDC, DEC, and IBM.

Compatibility

The package is compatible with TRS-80 disk BASIC. Disk BASIC is more forgiving in some things, like FOR . . . NEXT loops, but if you use *legal* disk BASIC the compiler will recognize everything (except, of course, things like EDIT and CLOAD). CLEAR is not needed by the compiler, but if it's in the source program it will be ignored and a nonfatal error message will be given (which may be ignored). Also, there's no provision for data I/O with tapes. There are a few other minor differences, but almost any program written in standard TRS-80 BASIC will compile successfully. The reverse, however, is not true. The compiler recognizes many statements and commands not used by TRS-80 BASIC.

OPTION BASE	SWAP	WAIT
WHILE	WEND	WIDTH
FRE	HEX$	OCT$
INP(I)	INPUT$	LPOS
POS	SPACE$	SPC
CHAIN	%INCLUDE	

Table 2: *Some statements, commands, etc., supported by Microsoft's compiled BASIC, but not by TRS-80 disk BASIC.*

Speed

All compiled programs are much faster, but the compilation process itself takes some time. The trivial program in listing 1 took less than two minutes to compile and link. A game using 11K bytes took one minute and 46 seconds to compile and two minutes and 50 seconds to link without a listing file. With a BASIC listing file but no object code between the lines, compilation took two minutes and 11 seconds, and the listing file required about 14K bytes or 13 "grans." It was impossible to compile the program with object code; the listing file needed more than 100 grans of disk space. This is a problem with the compiler that's not mentioned in the documentation; object code listings may need more storage than is available on any blank disk. However, it's probably never necessary to get a complete listing file with object code. A "−N" switch after the BASCOM line will inhibit the object code.

Some differences in run times for various interpreted and compiled programs are given in table 1, which shows the execution times for statements placed in line 30 of listing 1. Speed increases vary from more than 40 times, with integer variables in simple functions, to less than three times faster using SIN, COS, and similar functions. Nevertheless, there's always a speed increase that varies depending on the program.

Special Features

Compiled BASIC has many features unavailable in interpreted TRS-80 BASIC. In fact, they're not all listed in the documentation. Table 2 gives the additional statements and commands, although they are too numerous to fully describe. For example, SWAP(A,B) exchanges the value assigned to the two variables, and transcendental functions will return double precision. Perhaps the most important are WHILE and WEND statements; they allow writing structured program code. Variables may be of any length; that is, the compiler will consider J, JOS, and JOSEPH to be different variables. This may pose a problem when compiling a program that uses variable abbreviations; the compiler may recognize more variables than were originally intended.

Microsoft's original BASIC compiler had many defects, but all of the problems seem cured in this new version. I have some BASIC programs that will not compile using BASCOM, but that's always because standard TRS-80 conventions were not used. For example, Radio Shack's backgammon game will not compile because it branches to subroutines from within a loop; that is disallowed but forgiven by interpreted BASIC. Also, some things may be mistaken for bugs. For example, I thought there were problems with linking because L80 is different for Microsoft FORTRAN and BASIC. But the two act the same if a "−R" switch is used with the BASIC version.

I've yet to find any "real" bugs—only things that I either misinterpreted or didn't understand.

If you have code that you want to run faster, or if you need any of the features like a FORTRAN library, this is definitely a worthwhile product. If you're not accustomed to a compiler, compilation may be annoying. But this is a professional package, just as flexible and much easier to use than some compilers on mainframe computers.

Conclusions

Microsoft's BASIC compiler allows compilation of any BASIC program written for a disk-based TRS-80. This results in a three to 30 times increase in execution speed. The system includes a compiler (BASCOM), linker (L80), routine library (BASLIB), and run-time package (BRUN). For most purposes, 48 K bytes of memory and two disk drives are needed. The package is nearly identical to the interpreter that Microsoft designed for the TRS-80.

The software is readily used by those familiar with a compiler and compilation is quick. The documentation is confusing but complete, and a novice should be operating the system within an hour. Full use of its very flexible and extensive special features will require several days' study, which would be reduced with better documentation.

There are more than 20 features in the package that are not available in disk BASIC, including structured loops and calls to FORTRAN subroutines. Because of ambiguities in documentation, full use of the features requires long study and experimentation.

This is a very professional software package that gives the TRS-80 features found only on much larger systems. Except for the documentation, the package is superlative in all respects. ■

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LDOS—Disk Operating System for the TRS-80

Tim Daneliuk
4927 North Rockwell
Chicago, IL 60625

The TRS-80 microcomputer has evolved from a rather simple, cassette-based experimenter's delight to a complex and powerful disk-centered system. With disks came the necessity of a DOS (disk operating system) for control and communication with the computer. The first DOS came from Radio Shack, but independent vendors have since released others. The latest of these is LDOS from Logical Systems Inc.

LDOS was created out of need. Lobo Drives International wanted to market a new disk interface for the TRS-80 Model I that supported not only 5¼-inch floppy disks, but 8-inch and hard disks as well. Additionally, the floppy-disk interface supported both single- and double-density operation. At the time of the hardware design, no existing DOS could support this diversity of hardware. Therefore, LDOS was created. Originally, it started as a debugged and enhanced version of VTOS 4.0. However, the present version is essentially all new code. VTOS users will be quite comfortable with LDOS because the command structure and syntax of VTOS have been largely maintained. The present version of LDOS supports both the Radio Shack expansion interface and the Lobo LX-80 interface. It is compatible with TRSDOS 2.3. Also, it supports both the Percom Doubler and double-sided operation. A version of LDOS is also available for the TRS-80 Model III.

It is always difficult to review a software product of this magnitude. I hope I have successfully avoided the tendency to get lost in infinite detail. I will stress the highlights of the system based on extensive use of LDOS 5.0.2 on a Model I and limited use of LDOS 5.1 on a Model III. The features discussed reflect primarily LDOS 5.1. As this is being written, this latest version, called 5.1.1 for the Model I, has just been released. Therefore, the operating features of both Model I and Model III LDOS are identical.

At a Glance

Name
LDOS (logical disk operating system)

Type
Systems software/disk operating system

Manufacturer
Logical Systems Inc.
11520 North Port Washington Rd.
Mequon, WI 53092
(414) 241-3066

Price
$169

Format
5¼-inch floppy disk

Computer
TRS-80 Model I or III with 32K bytes of memory and a disk drive

Language
Z80 machine language

Documentation
Approximately 250 pages in a three-ring binder

Audience
All TRS-80 disk system users

The LDOS Command Library

TRSDOS 2.3 could be viewed as a subset of LDOS. Every TRSDOS command has been implemented, and most have been significantly enhanced. LDOS also provides many new commands never previously available on any one TRS-80 DOS. Table 1 contains a brief listing and descriptions of the major enhancements and extensions found in LDOS. The major features are described below.

If you do any assembly-language programming, you will find the LDOS extended DEBUG a tremendous tool. All of the old commands are included, but many new ones have been added, too. Some of the extensions are:

- enter data directly into entire sections of memory
- fill a block of memory with a specific byte
- jump over a byte in program execution
- locate first occurrence of a specific byte or word in memory
- print a block of memory
- send or display a byte to or from any I/O (input/output) port
- type ASCII (American Standard Code for Information Interchange) characters directly into memory
- compare two blocks of memory

There is also a disk read/write utility that allows reading or writing to any sector of any disk, even the directory sectors!

The fact that LDOS supports hard disks and 8-inch floppy disks is evident in the changes to the DIR (directory) command. An unconditional call for a disk directory on a 10-megabyte hard disk would be a messy proposition. LDOS allows directories

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by class and date. For example, a directory of only files with the extension "/TXT" could be shown. Or all files created on, before, or after a specific date could be shown. This is a real time-saver when you are trying to find a specific file in a full disk. Any DIR command also shows the amount of free space in kilobytes on a specific disk, as well as the usual disk name, creation date, and drive number.

The LINK and ROUTE commands are very sophisticated and offer features normally found only on minicomputer and mainframe operating systems. LDOS is a device-independent operating system. Each peripheral is seen by the operating system as a DCB (device control block) in memory independent of the actual hardware. This means that data can be transferred between peripherals (called devices) in any manner you want. Additionally, so-called dummy-devices can be created so that data intended for one destination can be made to go elsewhere (a disk file, for example). In essence, device-independence allows you to redirect I/O any way you like without having to rewrite the machine-language I/O drivers. This may sound terribly complicated, but it is extremely easy to use and offers unbelievable versatility.

The ROUTE command allows you to change the destination of data. For example, routing the video to the line printer forces anything normally displayed on the screen to be printed on the printer. Another application for ROUTE is to send anything from the RS-232 serial port to a disk file, instead of the screen, when the computer is unattended. LINK is similar to ROUTE in function. However, instead of redirecting data to another device, it simultaneously adds a second (or third, or fourth . . .) destination device. This would allow you to send anything appearing on the screen to the printer, too, or vice versa. I have a disassembler that only goes to the screen. By linking the video display to the printer, the disassembled code appearing on the screen is simultaneously sent to the printer, thus providing hard copy. The LINK command takes 10 seconds to type in; writing a new I/O driver could have taken days.

The SPOOL command has many uses, but its greatest application is when long printouts are required. Rather than tying up the computer completely while printing, SPOOL sends the data to be printed to a buffer located in memory or on a disk. Then, as the computer has time (in between keystrokes, for example), the data are sent to the printer. You can choose the size of the buffer, as well as whether to spool to memory or the disk. When using SPOOL, it seems that the TRS-80 is doing two things at once. However, it's just using time much more efficiently! Small-business users will love this feature because you can print a long report or a general ledger and use the computer for other things at the same time.

A final highlight of the LDOS library is the SYSTEM command. This allows you to customize LDOS for a particular installation. The disk-drive stepping rate, blinking cursor, keyboard type-ahead, and break key disable are but a few of the many features that can be configured. The final configuration can then be saved. Each time that LDOS system disk is booted, the configuration is also loaded. SYSTEM will be a real favorite with a single-drive user because it allows you to load many of the "/SYS" files into memory. This in turn frees a great deal of disk space for data. It also has the effect of speeding up disk I/O since overlays are not being called from the disk. Potentially, you could have the full operating system at your disposal, and about 60K bytes of disk space in a single-drive, single-density, 35-track system. Finally, SYSTEM allows you to reassign which physical drive is logical drive 0. You must load LDOS the usual way, but after that anything goes. This will find application among Model III users who have a 35-track drive left from their Model I. By making this external drive the system drive, the two higher-capacity 40- or 80-track drives in the Model III

APPEND	Can ECHO to screen while appending, and can back up 1 byte in destination file to merge Scripsit files.
ATTRIB	Can make files VISible and INVisible.
AUTO	Can disable BREAK key.
BOOT	Software reset "button." Reloads LDOS.
BUILD	Creates ASCII or HEX files for PATCHing, JCL, etc.
COPY	Simplified syntax. Can specify LRL. CLONE attributes of source file. ECHO characters to screen while copying. Single-drive copy from non-system disk.
CREATE	Preallocate disk space for a file in either kilobytes or number of records.
DEBUG	Extended significantly (see text).
DEVICE	Shows all important disk-configuration data.
DIR	Extended significantly (see text).
DO	Used to execute JCL file.
DUMP	Will dump in ASCII. End of text marker can be specified.
FILTER	Modify I/O flow.
FREE	Shows amount of space used and available, creation date, disk name, number of directory entries used and available, free space in K, and space map. Can be sent to printer.
LINK	Change I/O flow (see text).
LIST	Can number lines, dump in HEX, expand tabs, begin at specific record or line number, specify LRL, and output to printer.
LOAD	Can load from a nonsystem disk in single-drive systems.
MEMORY	Can show or modify top of memory. Can display, jump to, or modify specific memory locations.
PURGE	Multiple kill of files.
RESET	Reconnect peripherals to standard I/O drivers.
ROUTE	Modify I/O flow (see text).
RUN	Execute file from nonsystem disk on a single-drive system.
SET	Connect device to new I/O driver routine.
SPOOL	Data spooler (see text).
SYSTEM	Configure system parameters (see text).

Table 1: *The major enhancements of LDOS as compared to TRSDOS 2.3. Not all library features are listed here.*

are free to handle data disks.

LDOS Utilities

LDOS includes the familiar BACKUP and FORMAT utilities, which have been greatly enhanced, plus several new utilities. As with the command functions, BACKUP and FORMAT provide support for larger disk drives. BACKUP by class can be invoked, for example, to back up only nonsystem files. FORMAT provides the necessary functions to format disks of various sizes, densities, and single- or double-sided usage. As with most sophisticated operating systems, LDOS requires that a disk be formatted before a backup is allowed.

CMDFILE is a utility that allows the transfer of files stored on tape to disk, or vice versa. Where necessary, the utility will offset program locations from the tape version to insure that no conflict with the operating system is encountered. Disk-to-disk transfers are also supported. The PATCH utility allows modification of disk files to make minor changes or repairs without having to rewrite the entire file. Model III LDOS comes with a CONV utility to convert Model III TRSDOS disks to LDOS.

A final utility of interest is LCOMM. It provides communications software compatible with both the Radio Shack and the Lobo LX-80 serial ports. This is *not* a "dumb-terminal" program, but a full-blown communications package with features like file transfers and downloading.

LDOS Filters and Drivers

One of the unique features of LDOS is its ability to "filter" data. By loading an appropriate program, it is possible to modify data before they are sent to a particular device. Three such filters are provided with LDOS, but documentation is provided to help the assembly-language programmer write others. The KEYSTROKE MULTIPLY filter allows you to program any key to generate a phrase when pressed. I programmed some commonly used BASIC phrases into my keyboard. By pressing CLEAR and G together, the phrase GOTO is generated. Another possible application for this filter would be to reduce complicated DOS commands to a single keystroke. LDOS does provide abbreviation for certain commonly used library commands such as FREE and DIR by means of the MINIDOS filter. The third filter is the PRINTER filter. Its features include adding a linefeed after a carriage return, specifying the number of characters to be printed on a line, and setting the left margin of the printed page.

Logical Systems is also releasing an entire disk of filter routines to be used with LDOS. This disk will sell for $60. It has many extended features, such as redefining every ASCII character. This would allow, for example, translation from ASCII to another data code such as EBCDIC. Another filter on this disk allows decimal and hexadecimal arithmetic while in another program (EDTASM, for example).

LDOS has a provision for loading custom I/O drivers as well. With one command, it is possible to change peripheral control from the LDOS drivers to one you have written. An RS-232 driver is provided for applications involving the serial port.

Job Control Language

It is impossible to do justice to the Job Control Language (JCL) feature short of writing a separate review of it. This is essentially a way of writing programs using LDOS library commands. Let's say you want to load a disk, and from then on have hands-off operation while the computer updates your mailing list, realphabetizes it, and prints labels. Normally, you would have to type in four separate DOS and BASIC commands:

```
BASIC
RUN "NEWDATA"
RUN "ALPHABET"
RUN "LABELS"
```

In LDOS, you simply create a file with these commands in it (using the LDOS BUILD command or a text editor such as Scripsit). Then tell LDOS to DO this file and sit *back!* Program execution is automatic. JCL

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also has the capability of prompting the user for input from the keyboard, to make decisions, to wait for a specific time on the clock before executing, and many other features. One application could be running long business programs unattended at night. This feature alone is worth the entire package price.

LBASIC

As with Disk BASIC 2.2, LBASIC is an adjunct to the BASIC interpreter in the TRS-80. It is compatible with programs written in Radio Shack BASIC, but has extended features that significantly enhance the language.

LBASIC adds many new random and sequential file controls. One of the best is the implementation of the Blocked File mode. In this mode of operation, an LRL (logical record length) between 1 and 256 bytes per record may be selected. This means that although the physical record size is still 256 bytes per record, you can deal with logical records that are less than this. Let's say you wanted to write a random-access file that contained nothing but names up to 32 characters long. Rather than FIELDing the buffer for eight separate data fields and writing 256-byte records, LBASIC allows you to have records that are exactly 32 bytes long as far as *you* are concerned, while maintaining actual physical records that are 256 bytes. Another random-access file control, OPEN, has been modified to allow the opening of a file only if it already exists or, conversely, only if it does *not* already exist.

The sequential file controls have been enhanced as well. It is now possible to write to the end of (append) a sequential file directly without having to first load the file into memory, modify it, and write it back to disk. As with the random files, OPEN can be made dependent upon whether the file does or does not already exist.

LBASIC implements some features that greatly enhance writing and debugging programs. The more commonly used BASIC commands such as AUTO, EDIT, and LIST have been reduced to a single-letter command, and it is possible to single-step through a BASIC program. To facilitate program documentation and debugging, LBASIC includes a powerful line-renumber command and a cross-reference generator.

Several totally new BASIC commands have been added. RESTORE lets you go to a specific line of a program rather than always to the first DATA statement. When chaining programs, it is possible to specify at what line of the next program execution is to begin. Variables can also be passed from program to program while chaining. Thus, it is no longer necessary to save the variables in a file and read them back in when the next program has been loaded. A final addition is the ability to reset the EOF (end-of-file) marker in a random file, effectively allowing you to make random files smaller at will.

A final enhancement in LBASIC is the extended use of the CMD com-


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mand. Any legal LDOS command that does not affect protected memory can be executed from within LBASIC. To do a directory, for example, simply type in CMD "DIR". You can also load "/CMD" files from LBASIC by typing in CMD "filespec".

Documentation

It is claimed that of the approximately $100,000 spent on the LDOS project, the manual alone cost more than $25,000 to develop. This is not difficult to believe because LDOS has the best, most comprehensive documentation and manufacturer support I've ever seen for a microcomputer. In excess of 250 pages, the LDOS manual is plainly the work of professionals. It will bring particular joy to assembly-language programmers because all major system entry vectors are thoroughly documented and all old *documented* TRSDOS vectors have been maintained. (I gained a great deal of insight into TRSDOS by reading the LDOS technical section.) The nontechnical user is by no means left out though. The manual is extremely readable and full of good examples.

The documentation is further supported by a toll-free telephone number, an excellent update policy, a Micronet bulletin board, and a quarterly news magazine. The phone-in customer service is available for four hours daily. The magazine is free for the first year. New releases of LDOS can be obtained by sending $5 and the original master disk to the manufacturer. If you prefer, you can update LDOS by logging in to Micronet and copying the updated version at no charge. As newer versions of LDOS become available, existing owners will be able to upgrade to the new version for a nominal fee (depending on the nature of the new revision). In short, the LDOS documentation and support system have no peers. They can be expected to become the standard by which all others are measured.

Benchmarks

LDOS boots quickly and seems to operate quite efficiently. One of its nicer features is the fact that the real-time clock is kept on during disk I/O operation. While this keeps the clock much more accurate than other systems, it can lead to a rather mysterious problem. If the disk drive is turning at exactly 300 rpm (revolutions per minute), the interrupt for the clock can occur at the same time the directory track becomes available to be read. This can result in long waits during disk I/O. The problem is remedied by reducing disk-drive speed by several rpm. The first quarterly magazine includes a BASIC program that indicates drive speed allowing you to see if your drives need a slight readjustment. The 15 minutes it takes to do this minor correction is a small price to pay for the added clock accuracy, though, and the problem is intermittent and minor at most.

Listing 1 is the Benchmark program used to compare the speeds of *LDOS*

Listing 1: *The Benchmark program used to compare the speed of TRSDOS and LDOS.*

```
100 CLEAR 1000
110 CLS
120 DEFINT A-Z
130 ' ** Program to test speed of system **
139 ' Set display delay
140 DODELAY=2000
200 PRINT@ 256,"Do you wish to make a <R>ead or <W>rite test
??";:INPUT MODE$
210 ' Set Read or Write mode
220 IF MODE$="R" OR MODE$="r" THEN MODE=0:GOTO 300
230 IF MODE$="W" OR MODE$="w" THEN MODE=1:GOTO 300
240 GOSUB 9999:GOTO 200
300 CLS
310 PRINT@256," What is the name of the file to use ??";:INPUT
FILE$
320 IF LEFT$(FILE$,1)<"A" OR LEN(FILE$)>12 THEN GOSUB 9999:GOTO
300
340 CLS
350 PRINT@256," Which drive shall be used (0 to 7) ??";:INPUT
DRIVE$
360 IF LEN(DRIVE$)>1 OR VAL(DRIVE$)>7 THEN GOSUB 9999:GOTO 340
370 CLS
380 PRINT@256," What Logical record length (1 to 256)??";:INPUT
LRL$
390 IF VAL(LRL$)<1 OR VAL(LRL$)>256 THEN GOSUB 9999:GOTO 370
400 CLS
410 PRINT@256," How many records shall be Processed ??";:INPUT
REC
420 IF MODE THEN CLS:PRINT@256," If the file exists do you want
it KILLED (Y/N) ??";:INPUT KI$: ELSE GOTO 500
430 IF KI$="Y" OR KI$="y" THEN KI=1
500 CLS
510 FILE$=FILE$+":"+DRIVE$:PRINT@256," Filename    : ";FILE$
520 PRINT@384,                         " Record size : ";LRL$
530 PRINT@512,                         " # of Records: ";REC
540 PRINT@640,                         " File MODE   : ";:IF MODE
 THEN PRINT"WRITE" ELSE PRINT"READ"
550 PRINT:PRINT" IS THIS CORRECT (Y/N) ??";:INPUT GO$
560 IF GO$="n" OR GO$="N" THEN RUN
600 IF KI THEN ON ERROR GOTO 15000:IF MODE THEN KILL FILE$
601 ON ERROR GOTO 0
602 Q$="HELLO"+"GOODBYE"
605 SIZE=VAL(LRL$):IF LRL$="256" THEN LRL$=""
610 OPEN"r",1,FILE$,VAL(LRL$):FIELD #1, SIZE-1 AS REC$
620 PRINT@288,"START  :";TIME$
630 PRINT@416,"FINISH :";
640 PRINT@544,"RECORD :";
690 IF MODE THEN 800
700 FOR L=1 TO REC:PRINT@552,L;:GET 1,L:IF REC$=Q$ THEN 1000
ELSE NEXT:CLOSE:GOTO 900
800 FOR L=1 TO REC:PRINT@ 552,L;:LSET REC$=STR$(L)+"This is a
test of file handling in Basic":PUT 1,L:NEXT:CLOSE:GOTO 900
900 PRINT@424,TIME$;:PRINT@900,;:END
1000 PRINT" E R R O R ":GOTO 900
9999 CLS:PRINT@400," I N V A L I D   R E S P O N S E ";
10000 FOR TIMER= 1 TO DODELAY:NEXT  ' ** PAUSE LOOP
10001 CLS:RETURN
15000 RESUME NEXT
```





and TRSDOS. Table 2 is a summary of the results of that benchmark. For the Model III, TRSDOS 1.3 was used. The Model I benchmark presented a problem since TRSDOS 2.3 does not officially support variable LRLs (i.e., logical record lengths less than 256 bytes). The latest version, TRSDOS 2.3B, does support variable LRLs on the Radio Shack Compiler BASIC package, but not with the interpreter. Variable LRLs are partially implemented in TRSDOS 2.3 and 2.3B, but they cause errors to occur. In investigating this, I discovered that it was possible to write records in this file mode, but not to read them. Furthermore, the write procedure appeared to work fine, except that when the file was to be CLOSEd an error message appeared. Consequently, the timings given for TRSDOS on the Model I should not be treated as true benchmarks. They are included here only as a point of interest. It is interesting to note that, even with the errors being generated, the figures for the Model I and Model III are remarkably *similar*. This seems to indicate that, if Radio Shack ever implemented variable LRLs on the Model I, no significant improvement in efficiency could be expected unless the entire procedure was rewritten.

Summary and Conclusions

It is probably apparent that I really like LDOS. It is by far the most sophisticated piece of systems software available for the TRS-80 (and probably for any computer priced under $5000). It offers unprecedented features, giving the TRS-80 new applications previously impossible without a massive programming effort. I had been considering selling my Model I and upgrading. After using LDOS, it became apparent that, while I might improve the hardware, I would be hard-pressed to come up with a more usable and better supported system in an affordable price range.

Specifically, LDOS offers these unique features:

- A user-oriented DOS that doesn't require in-depth technical knowledge to use well.
- A level of documentation and technical support almost unheard of in anything but minicomputers and mainframes.
- Virtually problem-free operation. In the months I have used LDOS, the only problem encountered was the disk-speed problem mentioned earlier.
- The possibility of true portability between members of the TRS-80 family, as well as some S-100 computers. Versions of LDOS for the Model II and certain S-100 computers are planned. These will probably be CP/M-compatible to some extent and will allow transporting data disks between any machines running under LDOS (provided the media are compatible).
- An exceptional bargain! If the individual features of LDOS were bought separately, the price would be near $1000. The SPOOL feature alone would cost almost as much as the complete LDOS package.

It is difficult to conceive of a TRS-80 user who would not benefit from LDOS. In fact, the overall programming efficiency should at least double. Even if you are using another advanced DOS, it would be worthwhile to look into LDOS because its advanced features are yet to be rivaled in any one competitive operating system. If you are about to purchase a disk system or a new DOS, you'll find LDOS to be a professional, debugged, and efficient tool that will free your time and talents to write better applications software.■

	Model III				Model I			
	TRSDOS 1.3		LDOS 5.1		TRSDOS 2.3B		LDOS 5.0.2	
Function	Real Time	Clock Time	Real Time	Clock Time	Real Time	Clock Time	Real Time	Clock Time
Write New File LRL = 2 2000 Records	13:23	2:09	1:28	1:28	13:36	------	1:37	1:38
Write To Existing File LRL = 2 200 Records	1:21	0:13	0:09	0:09	1:23	------	0:11	0:11
Read Existing File LRL = 2 2000 Records	6:37	1:54	0:49	0:49	------	------	1:05	1:06
Write New File LRL = 128 200 Records	1:52	0:26	1:05	1:05	1:42	------	1:28	1:30
Write New File LRL = 256 100 Records	------	------	------	------	0:45	0:20	0:55	0:55
Read Existing File LRL = 256 50 Records	------	------	------	------	------	------	0:10	0:11

Table 2: *The results from the Benchmark program. Times given are in minutes and seconds. Blank spaces indicate tests not run on the Model III, or not possible with the Model I.*

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COBOL for the TRS-80 Models I and III

Rowland Archer Jr.
Flint Ridge Apartment 59
Hillsborough, NC 27278

COBOL on a TRS-80 Model I? Yes, I was skeptical myself. Visions of COBOL's notoriously verbose source code rapidly filling memory and floppy disks led me to believe that Radio Shack had probably exceeded the limitations of the TRS-80 this time. I have been surprised in the past by some things people have converted from mainframes and minicomputers to microcomputers, but COBOL seemed like too much. Now, after substantial use of the system, I can happily report that Radio Shack's COBOL package is professionally done and well suited to the TRS-80.

COBOL is the most widely used programming language in the world. Over the years, the American National Standards Institute (ANSI) CODASYL committee has overseen the evolution of COBOL into a powerful language highly suited for business applications. It is particularly strong in its file-handling capabilities. Also, Radio Shack has announced that all the business-application software it develops in the future for the TRS-80 Model II will be done in COBOL.

Radio Shack COBOL (RSCOBOL) is a complete COBOL program development system. It implements a substantial portion of the ANSI X3.23-1974 COBOL Standard (the most recently approved standard). The package contains two 5¼-inch floppy disks for the TRS-80 Model I and one for the Model III. My report is based on the use of the Model I system. The Model III version is supposed to be functionally identical.

The disks contain:

1. CEDIT, a line-oriented text editor for preparing COBOL source programs. This editor is similar to the one provided with the Model I EDTSAM (Editor-Assembler) package, with tab settings for COBOL and several additional commands.
2. The RSCOBOL compiler supplied in Z80 machine-language format. It produces an object file, listing file, and cross-reference list in a single pass over the source code.
3. The RUNCOBOL run-time package, including an interactive COBOL debugger. The output of the RSCOBOL compiler can be run immediately with no need to go through a linking/loading phase, such as the one required by Radio Shack's FORTRAN package.

At a Glance

Name
RSCOBOL

Type
TRS-80 COBOL development system

Author
Ryan-McFarland Corporation
Software Products Group
Aptos, CA 95003

Distributor
Tandy Corporation
One Tandy Center
Fort Worth, TX 76102
(817) 390-3583

Price
$199

Software
All software needed to run COBOL on both Model I and Model III TRS-80s, provided on three 5¼-inch floppy disks. This includes a line-oriented text editor, overlayed COBOL compiler, interactive COBOL debugger, and run-time package.

Software Format
Model I version requires TRSDOS 2.3B, which is provided with the package; Model III version requires TRSDOS 1.1, which is also provided.

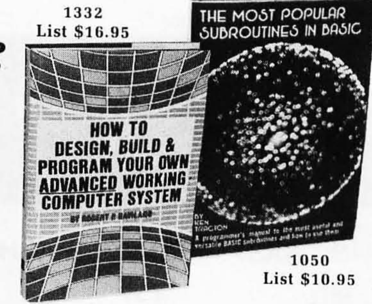
Computer
TRS-80 Model I or III with 48K bytes of RAM and at least two disk drives

Documentation
Concise but complete explanation of system operation; lengthy and thorough description of language; written in the style of a reference manual, not a tutorial; 368 pages.

Audience
Programmers in need of a COBOL development system for the TRS-80 Model I or III

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A New TRSDOS?

TRSDOS 2.3B is being provided with RSCOBOL, the new RSBASIC Model I BASIC Compiler, and the Series 1 Editor/Assembler. Each of these packages requires TRSDOS 2.3B and will not run under older versions of TRSDOS or other disk operating systems from alternate vendors (at least not at the time of this writing; the alternate DOS vendors will probably do something to remedy this situation).

Because of its dependence on certain features of TRSDOS 2.3B, the RSCOBOL package cannot be used without modification on systems that support double-density disk storage on the Model I, such as LDOS and NEWDOS/80, although the extra disk storage would certainly be useful for this package.

A utility, UPGRADE, is provided to convert a disk made with older versions of TRSDOS to run under 2.3B. However, once the disk is upgraded it can no longer be used with an older TRSDOS. UPGRADE also deletes any system (TRSDOS) files that happen to be on the disk being upgraded. Therefore, make sure you really want this to happen before you run the program!

The major change to TRSDOS is in the way it maintains the end-of-file (EOF) information in a disk's directory. The old systems maintained a 2-byte count of sectors in use by the file, plus a 1-byte offset of the last byte in use in the last sector. The new system maintains these 3 bytes differently. Together, the 3 bytes comprise a true total byte length of the file; if the EOF offset byte is not zero, the sector-count byte is one less than it was under the old system.

Ironically, this is the way Apparat's NEWDOS systems have always maintained the EOF internally. It was a "correction" to TRSDOS 2.1 noted in the documentation for NEWDOS 2.1, released more than two years ago. NEWDOS systems, however, convert the EOF data to be compatible with TRSDOS 2.3's "incorrect" method when they write the EOF to the disk directory. This makes NEWDOS-created disk files compatible with TRSDOS 2.3 and earlier systems, but incompatible with TRSDOS 2.3B—which uses the NEWDOS EOF method not only internally, but also in the disk directory. If you are confused, imagine the fun this creates when you have disks generated by both systems in your library!

In practice, this means that any machine-language program that does physical record disk I/O and maintains the EOF pointer itself will not function properly under TRSDOS 2.3B. For example, you cannot use Radio Shack's Scripsit to edit RSCOBOL source files without using a utility to move the files back and forth between TRSDOS 2.3 and 2.3B disks. However, Radio Shack provides only a utility for converting all the files on a 2.3 disk to 2.3B format. It is unfortunate that Radio Shack had to make these changes to TRSDOS, as they will certainly cause lots of confusion for thousands of TRS-80 users. [**Editor's Note:** TRSDOS 2.3B is not a replacement for TRSDOS 2.3. Radio Shack says it is only required for use with the RSCOBOL, Series 1 Editor/Assembler, and RSBASIC Compiler packages. . . .**SJW**]

New TRSDOS

One of the biggest surprises of this package was the introduction of a new version of DOS (disk operating system) for the Model I, TRSDOS 2.3B. I had seen no mention of this upgrade when I purchased RSCOBOL. Although this new release is only slightly different from TRSDOS 2.3, one of its changes is significant enough to make 2.3B disks incompatible with any other TRS-80 disk operating system, including NEWDOS, LDOS, TRSDOS 2.3, and its predecessors. This raises many "interesting" (read "painful") problems with file sharing between the various systems.

System Overview

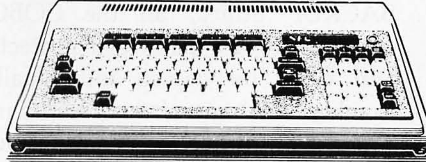
The RSCOBOL system is heavily disk oriented. It requires two disk

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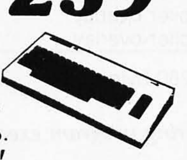


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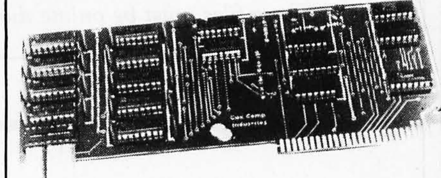
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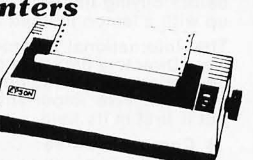


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drives. Since the compiler and the run-time module both use overlays, these disks must always be online during compilation and execution.

During compilation, the files in table 1 must be online. During execution of COBOL programs, the files in table 2 must be online. The best way to set up the disks in a two-drive system has the disk in drive 0 containing TRSDOS and either all the files needed to compile a program or all the files needed to run one. This allows the disk in drive 1 to be formatted as a "data disk," with all its space available for COBOL source code, object code, and/or the files used by applications programs. In fact, the disk containing both TRSDOS and the run-time system has enough space for a sizable COBOL object program, allowing drive 1 to be used entirely for data.

Unfortunately, Radio Shack didn't see it this way and its disks are set up differently. Only the run-time disk contains the TRSDOS system files. This disk does *not* contain the run-time debugger overlay, RSCBLD13/OBJ. That file is on the disk that must go in drive 1. The second disk contains the COBOL compiler, all overlays, and the COBOL editor. E since this disk does not conta TRSDOS, you must have a disk co taining TRSDOS in drive 0 while y are compiling. Where should you p your COBOL source code and obj code? Take your pick, but you mu share space on the same disk w either TRSDOS or the compiler a its overlays.

Why the fuss about file placeme After all, can't you just use COPY move the files around to achieve more logical placement? Due to an explicable move on Radio Shac part, you can't. Although the disks a whole can be copied using BACKUP utility, all the COB system files are password protec and can't be copied individual Frankly, the logic of this escapes r There is no protection against pira as both disks may be copied fre with no restrictions. But the licens owner of the system is prevent from moving individual files arou to increase the usefulness of system. Does anyone in Fort Wo care to explain this policy? It is eit a slip-up or Radio Shack is trying

File	Function	Size, GRANS
RUNCOBOL/CMD	COBOL Run-time	25
RSCBLD13/OBJ	Debugger overlay (Only needed if debugger is used)	2

*One GRAN = five 256-byte sectors, or 1280 bytes.

Table 1: *These files must be online during program compilation.*

File	Function	Size, GRANS
RSCOBOL/CMD	COBOL Compiler	23
RSCBL213/OBJ	Compiler overlay	6
RSCBL313/OBJ	Compiler overlay	6
RSCBL413/OBJ	Compiler overlay	5

*One GRAN = five 256-byte sectors, or 1280 bytes.

Table 2: *These files must be online during program execution.*

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Listing 1: *A sample program created using the COBOL development system. The program searches sequential disk files for records that match the key entered by the user. For a further explanation of how this COBOL program operates, see the text box on page 392.*

```
TRS-80 Model I/III COBOL (RM/COBOL 1.3B)          08/17/81  08:30:52   PAGE    1
SOURCE FILE: SAMPLE                          OPTION LIST: (T X L=1 O=1

LINE  DEBUG PG/LN  A...B.......................................................

             000100 IDENTIFICATION DIVISION.
             000110 PROGRAM-ID.
             000120     SAMPLE.
             000130 AUTHOR.
             000140     ROWLAND ARCHER.
             000150 DATE-WRITTEN.
             000160     29 JULY 1981.
             000170
             000180 ENVIRONMENT DIVISION.
             000190
             000200 CONFIGURATION SECTION.
             000210 SOURCE-COMPUTER.          RMC.
             000220 OBJECT-COMPUTER.          RMC.
             000230
             000240 INPUT-OUTPUT SECTION.
             000250 FILE-CONTROL.
             000260     SELECT INFILE ASSIGN TO INPUT, "INFILE/DAT:1".
             000270
             000280 DATA DIVISION.
             000290
             000300 FILE SECTION.
             000310 FD  INFILE
             000320     LABEL RECORDS ARE OMITTED.
             000330 01  INFILE-RECORD                   PIC X(80).
             000340
             000350 WORKING-STORAGE SECTION.
             000360
             000370 01  IN-RECORD.
             000380     05  RECORD-KEY                  PIC X(5).
             000390     05  REST-OF-RECORD              PIC X(75).
             000400
             000410 01  USER-QUITS-FLAG                 PIC XXX VALUE "NO".
             000420     88  USER-QUITS                          VALUE "YES".
             000430
             000440 01  MORE-DATA-REMAINS-FLAG          PIC XXX VALUE "YES".
             000450     88  NO-MORE-DATA-REMAINS                VALUE "NO".
             000460     88  MORE-DATA-REMAINS                   VALUE "YES".
             000470
             000480 01  REQUEST-KEY-MSG.
             000490     05  FILLER                      PIC X(40)
             000500     VALUE "TYPE SELECTION KEY (OR Q TO QUIT)".
             000510
             000520 01  WAIT-MSG.
             000530     05  FILLER                      PIC X(40)
             000540     VALUE "HIT <ENTER> TO CONTINUE".
             000550     05  WAIT-CHAR                   PIC X(2).
             000560
             000570 01  SELECT-KEY                      PIC X(5).
             000580
             000590/    EJECT
             000600 PROCEDURE DIVISION.
             000610
      >0000  000620 RECORD-SELECTION-AND-DISPLAY.
      >0000  000630     PERFORM GET-KEY-AND-SEARCH-FILE
             000640         UNTIL USER-QUITS.
      >000A  000650     STOP RUN.
             000660
      >000C  000670 GET-KEY-AND-SEARCH-FILE.
      >000C  000680     DISPLAY REQUEST-KEY-MSG, LINE 2, ERASE.
      >0014  000690     ACCEPT SELECT-KEY, POSITION 0, PROMPT, ECHO.
      >001C  000700     IF SELECT-KEY = "Q"
             000710         MOVE "YES" TO USER-QUITS-FLAG
             000720     ELSE
             000730         OPEN INPUT INFILE
             000740         PERFORM SEARCH-FILE-AND-DISPLAY-RECORD
             000750             UNTIL NO-MORE-DATA-REMAINS
             000760         CLOSE INFILE
             000770         MOVE "YES" TO MORE-DATA-REMAINS-FLAG
             000780         DISPLAY WAIT-MSG
             000790         ACCEPT WAIT-CHAR, POSITION 0, PROMPT, ECHO.
             000800
      >0050  000810 SEARCH-FILE-AND-DISPLAY-RECORD.
      >0050  000820     READ INFILE INTO IN-RECORD
             000830         AT END MOVE "NO" TO MORE-DATA-REMAINS-FLAG.
      >0060  000840     IF MORE-DATA-REMAINS
             000850         AND RECORD-KEY IS EQUAL TO SELECT-KEY
             000860         DISPLAY IN-RECORD.
             000870
             000880 END PROGRAM.
```

sell more disk drives. [**Editor's Note:** *Radio Shack replied saying that they have been using this same method of protecting their application software program files on all Model II software. They stressed that this does not represent a change in Tandy policy and emphasized that there are no restrictions on backups, only on copying individual files. . . .***SJW**]

For those who own disk editors such as Apparat's Superzap and are familiar with the disk-directory structure, it is a simple matter to overcome this problem by zapping the passwords. However, sensible use of the system should not be restricted to those with this knowledge.

One of the biggest surprises was the introduction of a new version of DOS for the Model I.

On the positive side, all components of the RSCOBOL system appear to honor the high memory pointer address stored at location hexadecimal 4049. This is not documented, but by using a disassembler I found code referencing hexadecimal 4049 during the start-up phase of both the compiler and the run-time package in a manner that suggested it was using hexadecimal 4049 as a pointer to the top of available memory. I have also been using a serial printer driver that protects itself by storing the last available address below itself at hexadecimal 4049. I have experienced no difficulties with the use of this driver during compilation and execution of COBOL programs. If you have an application for this, I recommend careful testing to make sure that it works.

In case you haven't seen a reference to this before, most Model I DOS systems, including TRSDOS 2.3B, store a pointer at location hexadecimal 4049 to the last byte of available memory. Anything stored after the address contained in hexadecimal 4049 is "protected"; programs that follow this protocol, as RSCOBOL appears to, are careful not

A Sample RSCOBOL Program

The sample RSCOBOL program shown in listing 1 prompts the user to type in a selection key (a string of up to five characters); it then reads through a sequentially organized disk file and compares the first five characters of each record in that file against the string typed in at the keyboard. All records whose first 5 bytes match the specified string are listed on the screen. This process is repeated until the user types Q instead of a key value.

The IDENTIFICATION DIVISION of the program, lines 1 through 7, is treated as a comment by the compiler. It tells the program's name, its author, and the date it was written.

The ENVIRONMENT DIVISION contains a CONFIGURATION SECTION. This identifies the SOURCE COMPUTER, or the system on which the program was compiled, as RMC (Ryan-McFarland COBOL). The OBJECT COMPUTER is the system on which the program will run; this is also RMC.

The INPUT-OUTPUT SECTION serves to establish connections between real disk file names and program identifiers for files. In this instance, line 17 logically connects the program file identifier INFILE with the TRSDOS file INFILE/DAT:1. A program variable could have been specified instead of the literal string INFILE/DAT:1, which would have allowed the file name to be specified at run-time rather than compile-time. The keyword INPUT specifies that this file is to be used for INPUT only.

The DATA DIVISION contains declarations for all program variables. Program variables in COBOL are referred to as "data items." The FILE SECTION contains a description of the disk records that will be read from the sequentially organized file INFILE. The WORKING-STORAGE SECTION contains declarations for all the program data items. IN-RECORD is the name for the "group" data item comprising RECORD-KEY and REST-OF-RECORD. The clause PIC X(5) on RECORD-KEY declares that data item to be a 5-byte long string of alphanumeric characters. (PIC stands for PICTURE; X stands for a number or an alphabetical character.)

The data item USER-QUITS-FLAG in line 32 illustrates one of COBOL's powerful tools for enhancing program readability. This flag is a 3-byte character string (PIC XXX) that initially has the value "NO". USER-QUITS in line 33 is a "Level 88" item; it gives a name to a possible value of USER-QUITS-FLAG. In line 54 of the program, the statement PERFORM GET-KEY-AND-SEARCH-FILE UNTIL USER-QUITS serves to repeatedly perform the code paragraph labeled GET-KEY-AND-SEARCH-FILE until the USER-QUITS-FLAG assumes the value named by USER-QUITS, in this case the string "YES". MORE-DATA-REMAINS-FLAG is another example of the use of "Level 88" data items.

REQUEST-KEY-MSG and WAIT-MSG are data items containing prompts to be printed on the screen using the DISPLAY statement. The VALUE clause gives them initial values.

The PROCEDURE DIVISION of a COBOL program is where the work gets done. It is divided into "paragraphs," each labeled by a name starting in the second column. The first paragraph is named RECORD-SELECTION-AND-DISPLAY. It contains only two statements: one that has been explained already, and STOP RUN, which halts program execution and returns control to TRSDOS.

The next paragraph, labeled GET-KEY-AND-SEARCH-FILE, is the one PERFORMed repeatedly by the first paragraph. It clears the screen (ERASE) and puts the REQUEST-KEY-MSG on the second line of the screen. It then ACCEPTs a user response from the keyboard, which goes into the data item called SELECT-KEY. POSITION 0 means leave the cursor where it is; PROMPT puts out a prompt of underscores the size of the data item SELECT-KEY; ECHO sends what is typed at the keyboard to the screen. The user is not allowed to type in more characters than will fit in the data item (one per underscore prompt character).

The IF statement in line 61 tests the value of SELECT-KEY typed by the user; if Q is typed, it puts the value "YES" in the USER-QUITS-FLAG. This causes termination of the program because the UNTIL USER-QUITS test in line 55 now evaluates as true.

If the user types anything other than Q, the ELSE part of the IF statement is executed starting at line 64. The file INFILE is opened for INPUT, and the paragraph SEARCH-FILE-AND-DISPLAY-RECORD is performed for each record in the file. When the file has been completely processed, it is closed in line 67, the flag MORE-DATA-REMAINS is reset to "YES" for the next time through the loop, and a messsage is displayed telling the user to hit the ENTER key to continue (lines 69 and 70).

The SEARCH-FILE-AND-DISPLAY-RECORD paragraph reads the next record from INFILE into the data item IN-RECORD. When the end of the file is reached, the word "NO" is put into the MORE-DATA-REMAINS-FLAG. This makes the test UNTIL NO-MORE-DATA-REMAINS in line 66 evaluate as true. If the end of the file is not reached, the RECORD-KEY field of the record read in from the file is compared to the SELECT-KEY typed in by the user. If they match, the entire record is displayed on the screen by the DISPLAY statement in line 77.

to use any memory past this point. This means that you can load any machine-language routines into high memory and set hexadecimal 4049 to point below them; the RSCOBOL system will not clobber your machine-language programs.

To give you a feeling for the system, I will explain the procedure followed to create, compile, and run the COBOL program shown in listing 1. This is a short (by COBOL standards) program that searches a sequential disk file (very similar to a BASIC sequential file) for records whose key fields match the one typed in at the keyboard. All matching records are displayed on the screen.

COBOL Editor

To create a COBOL source program, some type of text editor must be used. If you are accustomed to full-screen editors, you will be disap-

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Page scrolling (forward & backward)	Yes	Yes
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Automatic centering	Yes	Yes
Custom form letters	Yes	Yes
Saves text or binary files	Yes	No
Flexible formatting	Yes	Yes
Suppressed & continued page numbering	Yes	Yes
Hyphenation	No	Yes
Save text segment to a new file	Yes	Yes
Insert text from another file	Yes	Yes
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pointed with RSCOBOL's editor. Until there is a version of Scripsit or another full-screen editor that works with TRSDOS 2.3B, your only option is to use the line-oriented editor included with the RSCOBOL package. This editor, CEDIT, is written in assembly language. It is very similar to the original Model I EDTASM (Editor-Assembler) package, which in turn bears a close resemblance to the Level II BASIC editor. CEDIT does have a few enhancements, most noticeably the inclusion of a global "replace text" command. All CEDIT commands can be abbreviated to a single letter.

If you are accustomed to full-screen editors, you will be disappointed with RSCOBOL's editor.

CEDIT loads all the text to be edited into memory and saves everything to disk at once. It is not a memory buffer editor, such as the one supplied with Radio Shack's FORTRAN package. Thus, you are restricted to editing files that will fit in memory all at one time. CEDIT saves COBOL source programs on disk in a plain ASCII format; blanks and line numbers are not compressed in any way.

If you look through the CEDIT portion of the RSCOBOL manual, do not be misled by the section titled "Source File Format" on page 3. It implies that each line of source code takes up its own 256-byte disk record. Fortunately, this is not true. Source code lines are packed together and terminated by carriage returns, as in most other TRS-80 editors. The entire file is terminated by a hexadecimal 1A byte.

When you are ready to use CEDIT to create a COBOL source program, you must decide which disks to put online. I have a disk that contains TRSDOS, CEDIT, and the RSCOBOL compiler. This disk goes into drive 0, and a blank disk in drive 1 holds the COBOL source code being edited. Decide in advance which disk

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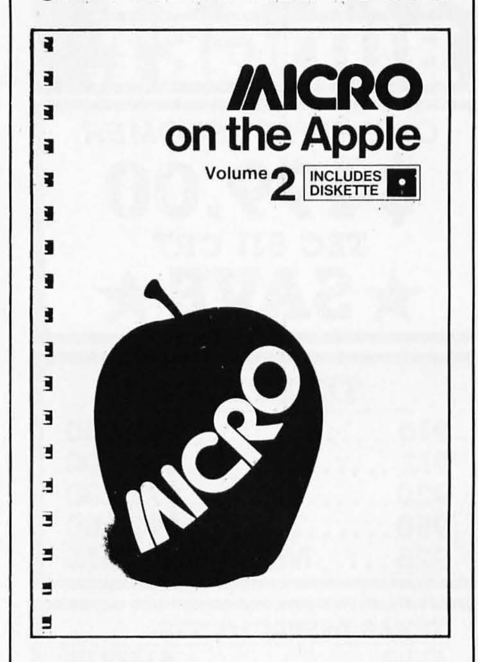
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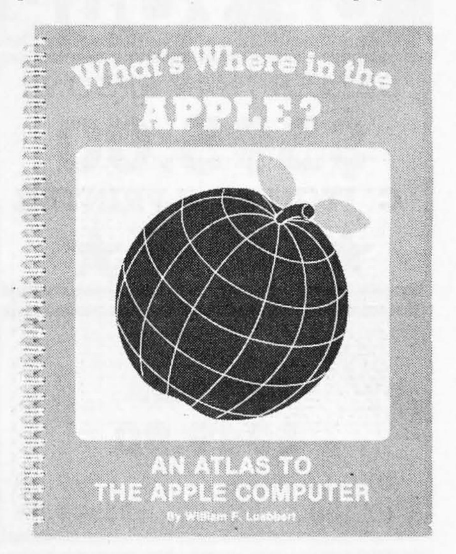
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will hold your COBOL program; once in the editor, you cannot go back to TRSDOS to look at the disk directory without losing what is in memory.

Since the COBOL language requires much similar information at the start of every program, I recommend that you create a "skeleton" or "template" file that contains this information. Then, when you create a new program, load this file and edit it as needed, rather than having to type in all the header information every time. Referring to listing 1, my skeleton file contains the IDENTIFICATION DIVISION, the ENVIRONMENT DIVISION, and part of the DATA DIVISION seen in this listing. My DATA DIVISION skeleton includes a FILE SECTION with a couple of FDs and the WORKING-STORAGE section with some often-used identifiers. Experience will help you decide which things are frequently repeated.

Line numbers are provided by the editor during the text creation process. The INSERT command, abbreviated I, is used much like BASIC's AUTO command; it automatically enters a line number, then you type the line. During text insertion, if the line number of a new line is the same as that of an existing line, the entire text is automatically renumbered from the current line to prevent overwriting the existing line. This gives you the advantage of never running out of room during text insertion. However, the disadvantage is that automatic renumbering causes the line numbers of existing lines to change. INSERT does not notify you that this has happened. This makes it more difficult to find and correct a line that was the cause of a compilation error, since error messages use the old line numbers. However, the offending line's contents are printed along with the error message. Therefore, you can use the editor's FIND command to locate the line.

FIND lets you search a range of source text for any string of characters. Another "new" command is CHANGE, which lets you change any string of characters to a different

string in as many places as you want. This is useful if you discover that a data item name is a COBOL reserved word, e.g., KEY. KEY can be changed to RECORD-KEY in all lines of a program with the CEDIT command:

```
C/KEY/RECORD-KEY/*
```

The "*" means change KEY to RECORD-KEY everywhere it occurs in the program. A number N, instead of "*", means change it the next N times it occurs. The "X" command behaves like CHANGE, but it asks you if the change should be made every time it finds a match for the search string.

Another useful command is MEMORY, which tells how big your program is in bytes and how much free memory is left.

CEDIT's remaining commands have counterparts in the Level II BASIC and EDTASM editors. These include commands to list a range of lines to the screen or printer, delete a range of lines, replace a range of lines, renumber the lines, and move to the top or bottom of the program file. The EDIT command provides editing of a single line; character insertion, deletion, and replacement; extension of the line, etc., in a manner nearly identical to Level II BASIC's EDIT command.

Once a program is completely typed in, it is saved to disk with the WRITE command. A default file name extension of /CBL is automatically provided. For example, typing W SAMPLE:1 saved the sample program's source file on drive 1 with a file name of SAMPLE/CBL.

RSCOBOL Compiler

All the files in table 1 must be online before compilation begins. Several options are available at compile-time. I used the command:

```
RSCOBOL SAMPLE
(P X L=1 O=1)
```

to compile the sample program. The options selected are printed at the top of each listing page. The P option means send a listing to the printer; an

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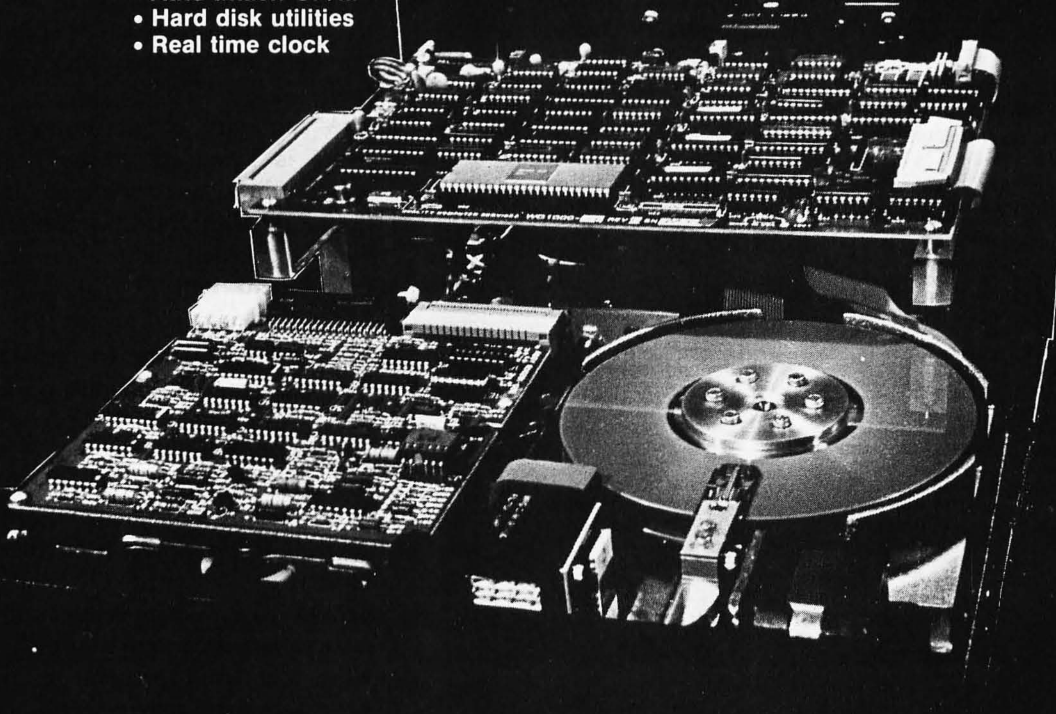
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xample is listing 1. The X option enerates a cross-reference of PRO-CEDURE and DATA DIVISION names. This appears at the end of isting 1. The L=1 option sends a copy of the listing to a disk file on drive 1. O=1 means put the object file on drive 1. If O=N had been selected, no object file would have been created.

RSCOBOL provides a COPY statement that allows COBOL source files to be included directly from disk in the compilation of a program. For example, a common record definition could be kept in a file called RECDEF, and the source program statement COPY RECDEF would open that file and compile its contents just as if it were part of the main source file being compiled.

One problem with the implementation of COPY is that all COPY files must be online during compilation. If one of them is not, the compilation aborts with an error message. It would have been simple to have the compiler pause if the file were not found and ask the user to mount the disk containing the file instead of aborting the compilation. This would have extended the size of source files that could be compiled for users with only two disk drives.

A couple of other options are available that were not used in the sample compilation. The D option compiles all the "debug" lines. Simply stated, any program line starting with D is ignored during compilation unless the D option is specified. Therefore, you can write your program with as much extra code as you want to help during debugging, and then have it all eliminated from the final version of your program by simply compiling without the D option. Debug code is commonly used to DISPLAY the value of some data item while testing a program. However, there is no restriction on the type of source code line that can be flagged in this way.

If the compiler finds any errors in your program, they are clearly marked with a pointer to the offending word and an error message in English. More than 70 error messages are possible, and I have never had a problem figuring out what they meant. Each error message has a brief explanation in the manual.

The compiler does not stop until it reaches the end of the source file, no matter how many errors it finds. This helps you to find as many errors as possible with a single compilation. If you specify the E option when you compile, only error messages are sent to the listing files. This is useful when compiling for the first time; you are likely to have some errors and can save wear and tear on your printer by printing only the error lines.

The T option directs the listing output to the screen. You can specify as many listing destinations as you wish—it is possible to direct output to a disk file, the printer, and the screen all at once. The sample program in listing 1 creates a disk file and a printout at the same time.

As you can see from listing 1, the compiler provides a complete program listing. The date and time of compilation appear at the top of each page, along with the name of the source file and any options selected. The leftmost number in each line is a line number supplied by the compiler. The next column contains information needed when using the interactive debugger. Next is the editor line number, and then the source code line itself.

A summary of all program data items is provided in the order in which they were defined in the DATA DIVISION. Information provided for each data item includes from left to right:

- its address relative to the start of data storage, for use during debugging
- its size in bytes
- a three-character type code used during debugging; ANS = alphanumeric, GRP = group, etc. (there are 12 in all)
- the "Order," which is the number of subscripts a data item requires
- the data item type name in English
- the data item name

This listing is followed by the size of the read-only portion of the program (presumably the code block) in bytes, the size of the read/write portion (the data area) in bytes, and the

Listing 2: *A summary of all data items from the program in listing 1.*

```
TRS-80 Model I/III COBOL (RM/COBOL 1.3B)          08/17/81  08:30:52   PAGE    3
SOURCE FILE: SAMPLE                           OPTION LIST: (T X L=1 O=1

 ADDRESS   SIZE DEBUG ORDER TYPE                            NAME


             0              FILE                            INFILE
  >0000     80   ANS     0  ALPHANUMERIC                     INFILE-RECORD

  >0054     80   GRP     0  GROUP                           IN-RECORD
  >0054      5   ANS     0  ALPHANUMERIC                     RECORD-KEY
  >0059     75   ANS     0  ALPHANUMERIC                     REST-OF-RECORD

  >00A4      3   ANS     0  ALPHANUMERIC                    USER-QUITS-FLAG
                         0  CONDITION-NAME                   USER-QUITS

  >00A8      3   ANS     0  ALPHANUMERIC                    MORE-DATA-REMAINS-FLAG
                         0  CONDITION-NAME                   NO-MORE-DATA-REMAINS
                         0  CONDITION-NAME                   MORE-DATA-REMAINS

  >00AC     40   GRP     0  GROUP                           REQUEST-KEY-MSG

  >00D4     42   GRP     0  GROUP                           WAIT-MSG
  >00FC      2   ANS     0  ALPHANUMERIC                     WAIT-CHAR

  >00FE      5   ANS     0  ALPHANUMERIC                    SELECT-KEY

READ ONLY BYTE SIZE =            >0122

READ/WRITE BYTE SIZE =           >0142

OVERLAY SEGMENT BYTE SIZE =      >0000

TOTAL BYTE SIZE =                >0264

     0 ERRORS

     0 WARNINGS
```

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total size in bytes. The total size for the sample program and its data is hexadecimal 0264 (612 decimal) bytes, which is fairly compact for this COBOL program.

For the sample program, a cross-reference table was requested. All PROCEDURE and DATA DIVISION names are listed in alphabetical order. For each entry, the line numbers in which it is declared and referenced are given. The line numbers in which a data item is declared are surrounded by slashes. Lines in which the value of a data item may be altered are marked with asterisks, e.g., *0073* for the variable IN-RECORD. In line 73, IN-RECORD is the destination of a record read from INFILE.

The COBOL compiler resides from hexadecimal locations 5200 to AAFF in memory. This leaves hexadecimal 5500, or 21,760, bytes of memory free. The compiler is so large that it had to be split into overlays as shown in table 1. Different overlays are loaded from disk to compile different divisions of a COBOL program. It is not documented whether these overlays eat into the 21,760 bytes of free storage. A couple of internal error messages tell when the compiler's working storage has been exceeded. This could happen, for example, if a program has too many symbols to store in the compiler's symbol table.

If this should happen, the subroutine CALL can be used to alleviate the problem. A program can be split into a main program and subroutines, each separately compiled. At run-time, when the main program CALLs a subroutine, it is loaded dynamically from disk. This also provides a method for controlling memory usage at run-time. But it is not the only method. A single program can be broken into overlays. A program

Listing 3: *A cross-reference of all PROCEDURE and DATA DIVISION names in alphabetical order. The line number where it is declared and referenced is also listed.*

```
TRS-80 Model I/III COBOL (RM/COBOL 1.3B)           08/17/81  08:30:52  PAGE   4
SOURCE FILE: SAMPLE                             OPTION LIST: (T X L=1 O=1

CROSS REFERENCE                   /DECL/ *DEST*

GET-KEY-AND-SEARCH-FILE            0054  /0058/
INFILE                            /0017/ /0022/  0064   0067   0073
INFILE-RECORD                     /0024/
IN-RECORD                         /0028/ *0073*  0077
MORE-DATA-REMAINS                 /0037/  0075
MORE-DATA-REMAINS-FLAG            /0035/ *0068* *0074*
NO-MORE-DATA-REMAINS              /0036/  0066
RECORD-KEY                        /0029/  0076
RECORD-SELECTION-AND-DISPLAY      /0053/
REQUEST-KEY-MSG                   /0039/  0059
REST-OF-RECORD                    /0030/
SEARCH-FILE-AND-DISPLAY-RECORD     0065  /0072/
SELECT-KEY                        /0048/ *0060*  0061   0076
USER-QUITS                        /0033/  0055
USER-QUITS-FLAG                   /0032/ *0062*
WAIT-CHAR                         /0046/ *0070*
WAIT-MSG                          /0043/  0069
```

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segmented in this manner is compiled in one piece, but the overlays are loaded into memory dynamically at run-time when they are entered via a GOTO or PERFORM statement. These two options, CALL and overlays, combine to provide the most dynamic memory-management system that I have seen in any TRS-80 language.

A word on compiler performance. With both the input of source text and the output of object code involving disk I/O (input/output), and the compiler itself requiring several disk overlay loads during the course of a single compilation, this compiler is no speed demon. The sample program, with the options shown, took 135 seconds to compile. This works out to about 35 lines per minute. This includes printing a listing and creating a listing file on disk, both including cross-reference lists. Choosing options of T and E (create an object file on disk and print any errors on the screen), sped things up to about 50 lines per minute. It then took 95 seconds to compile the sample program.

Testing a Program

The RSCOBOL system provides a simple run-time interactive debugger. This debugger allows you to test many aspects of a COBOL program without having to program in a lot of special debugging statements. Combined with the compiler's D option described earlier, RSCOBOL provides a decent debugging environment.

To make full use of the interactive debugger requires a current printed listing of the program under test. A printer is not a prerequisite for use of RSCOBOL, but I strongly recommend having one.

The command RUNCOBOL invokes the RSCOBOL run-time module. The debugger is invoked by specifying the D option. Once in the debugger, a COBOL program can be single-stepped a sentence or group of sentences at a time. This is achieved by typing S, optionally followed by N (where N is the number of sentences to execute). To execute all the way up to a particular sentence, type A followed by the address in the DEBUG column preceding the sentence at which execution should stop.

The final debugger command is D. It is used to DUMP the contents of different data items in a readable format. For the sample program, by typing D 54, 5, ANS, the current value of the data item RECORD-KEY is displayed on the screen. It is permissible

A printer is not a prerequisite for use of RSCOBOL, but I strongly recommend having one.

to request the display of a data item in other than the default format; a hexadecimal dump is available, for example.

Some important features that this debugger lacks include:

1. The capability to alter data item values.
2. A way of setting program breakpoints. The current system lets you specify that execution should proceed to a particular COBOL sentence; it is desirable to be able to specify a number of points in the code at which execution should halt, passing control to the debugging monitor.
3. A way to reference data symbolically rather than requiring the use of hexadecimal values representing actual data-storage locations.
4. A way to step through the statements of a COBOL sentence. In listing 1, there is only one value in the DEBUG column for the entire range of program lines from 61 to 71. This value represents the beginning of the COBOL sentence starting with "IF". You cannot step partially through this sentence; you must execute it in full.

If you are not using the debugger, the RSCBLD13/OBJ file need not be present during run-time.

Run-Time Environment

The RSCOBOL package includes a substantial run-time module that must be resident during the execution of any COBOL program. The run-time code resides from locations hexadecimal 5200 to B1FF, leaving about 20K bytes of user program space. This is respectable for a small machine.

There is a trade-off in using a standard run-time module rather than linking in only those pieces specifically required by each program. Use of a run-time module allows much faster program development; the linking phase otherwise required is usually very time-consuming. It involves a lengthy search of a large library module to find those pieces required by a particular program. A run-time module also cuts down on the size of user programs; without one, every user program must contain a lot of the code that is otherwise in the run-time module, resulting in much duplicated code on a disk holding several user programs.

The disadvantage is that, in most cases, not all of the run-time code is needed for a particular program. Therefore, some memory space is taken up unnecessarily. RSCOBOL compensates for this somewhat with its overlay and CALL statements for memory management.

Two options besides D (invoke interactive debugger) are available at run-time:

1. S=nn..n: This option allows the setting of "switches" at run-time. A COBOL program can test for the value of these switches and make decisions accordingly. The eight switches each can assume the value 0 or 1.
2. T=hhhh: This sets the top memory address that will be used by RSCOBOL at run-time. It is used to protect user machine-language programs from the run-time system. As discussed previously, it appears that if your assembly-language program stores this value in location hexadecimal 4049 (for the Model I), the same effect is achieved.

Many English-language error

messages can appear at run-time. They are carefully documented in the RSCOBOL manual.

My overall impression of run-time performance is favorable. Every program I have written which reads from the disk, computes something, and writes the results to the printer has managed to keep the printer moving at full speed (60 characters per second bidirectional). Interpreted BASIC programs I have written, which perform similar formatted I/O with the PRINT USING statement, pause noticeably between the output of formatted data items. By comparison, RSCOBOL is quite snappy and moves right along.

Language Implementations

RSCOBOL is based on the ANSI X3.23-1974 COBOL Standard. The ANSI Standard defines "levels" of implementation for different aspects of the language. Table 3 lists the levels of implementation provided by RSCOBOL. The more advanced the implementation, the higher the level number. The Federal Information Processing Standard (FIPS) lists 2 as a relatively "high" level of implementation for most language components. RSCOBOL's implementation does quite respectably.

Table 3 is somewhat misleading in that there are exceptions to the levels of implementation stated, i.e., certain features defined by ANSI as part of a level are not implemented. A complete list of these exceptions is in the back of the RSCOBOL manual. Notable exceptions include:

- Multiple results are not supported in arithmetic statements. For example, you cannot state ADD A TO B C; you must state ADD A TO B and ADD A TO C.
- REMAINDER is not supported in the DIVIDE statement.
- INSPECT data items are restricted to a single character.
- Compound TALLYING and REPLACING clauses in the INSPECT statement are not supported.
- Exponentiation to a noninteger power is not supported.
- Abbreviated combined relation conditions are not supported. You cannot say IF A EQUALS 1 OR 2; you must say IF A EQUALS 1 OR A EQUALS 2.
- The STRING and UNSTRING statements are not supported.

Some extensions to the stated levels of implementation are available, mostly nonstandard. One that struck me as quite interesting was the inclusion of several statements having to do with the locking and unlocking of disk records. These statements allow simultaneous access to a disk file by multiple users in a controlled fashion.

It is worth mentioning that the rather powerful MOVE CORRESPONDING statement is implemented. This lets you move all like-named fields from one record to another with a single statement. MOVE CORRESPONDING is frequently left out of small-machine in plementations of COBOL. Also in plemented are ADD CORRESPOND ING and SUBTRACT CORRE SPONDING.

The ACCEPT and DISPLAY stat ments provide good capabilities f interacting with the display ar keyboard. In listing 1, the ACCEP statement in line 60 puts out a field underscore characters the size of t data item SELECT-KEY, and allov only that many characters to be i put. DISPLAY is a programmatical simple way of printing a data item contents on the screen.

Assembly-language programs c be called from RSCOBOL. They a dynamically loaded from disk ar must be in standard TRSDOS lo format. An arbitrary number parameters can be passed to assembly-language program via t USING clause of the CALL stat ment. Parameters are passed reference, i.e., the address of the da item itself is passed. This is a ve flexible system. Loading assembl language programs from disk at ru time gives the same flexibility f managing memory used by assembl language programs as for that us by COBOL subroutines.

File I/O

COBOL probably has the mc complete set of commercial fil handling statements of any languag It is a substantial challenge to impl ment them for a 48K-byte RAM, du floppy-disk Model I. RSCOBOL pr vides three major COBOL file type sequential, relative, and indexed s quential.

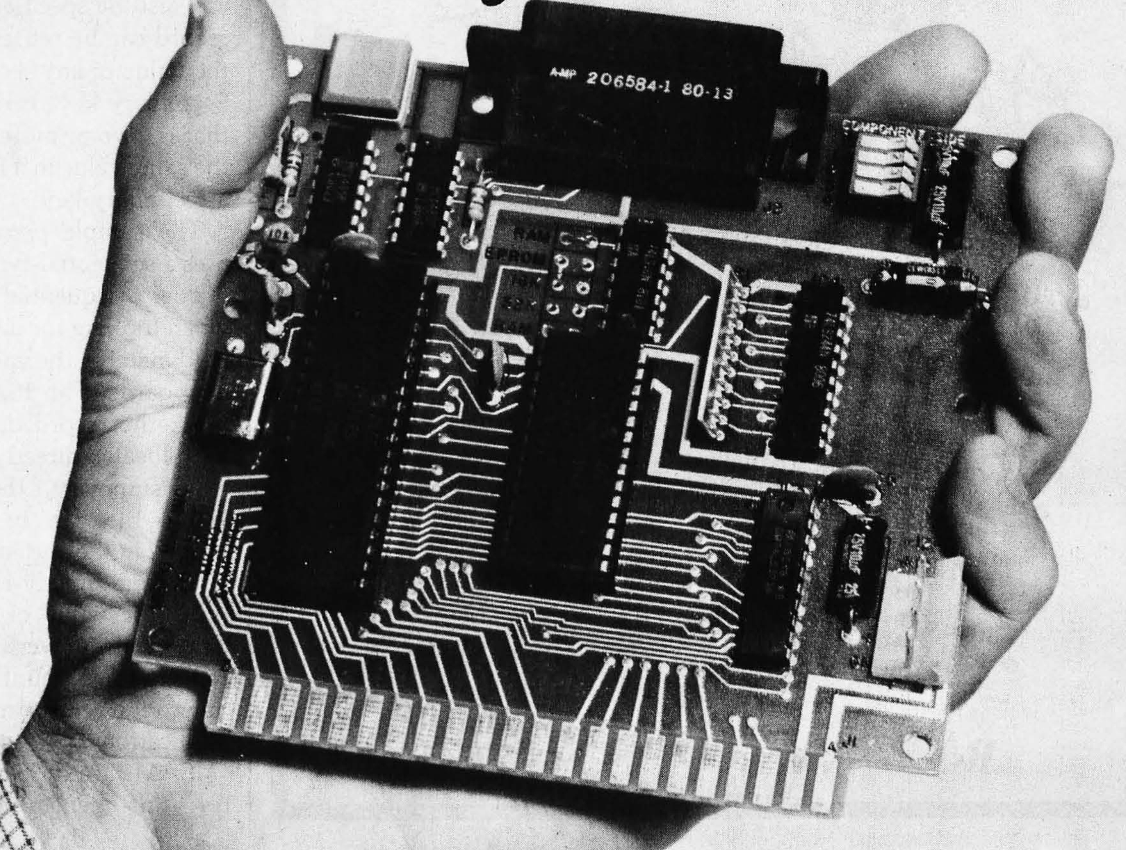
Sequential files can have fixed- variable-length records. Variabl length records contain a byte at t beginning of each record telling t length of that record. Lengths va from 2 to 255 bytes. Fixed-leng records do not contain any bytes te ing the length. Sequential files, co taining records of either type, must accessed in order, that is, one reco after the other in the order they we stored.

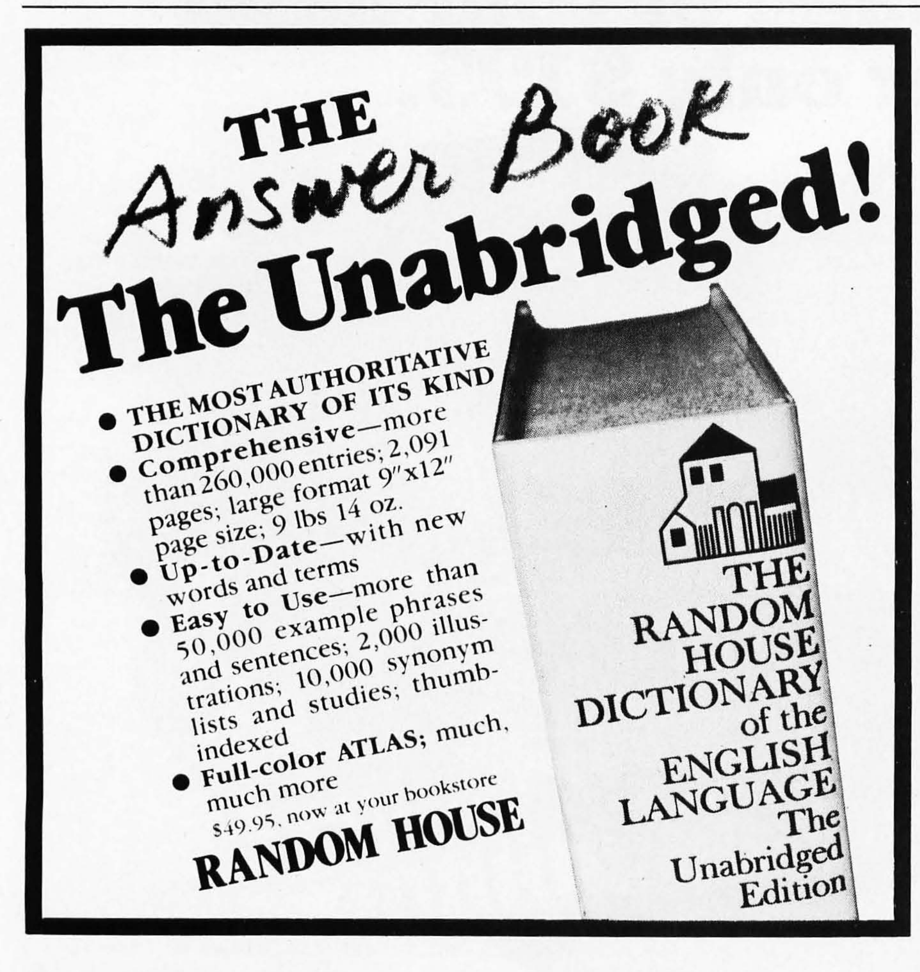
Relative or random files conta fixed-length records. Any particul

Function Module	Implementation
Nucleus	Level 2
Table Handling	Level 1 +
Sequential I/O	Level 2
Relative I/O	Level 2
Indexed I/O	Level 2
Sort-Merge	Null (nothing provided)
Report Writer	Null
Segmentation	Level 1
Library	Level 1
Debug	Nonstandard
Inter-program Communication	Level 1
Communication	Modified ACCEPT and DISPLAY for terminal communication

Table 3: *Radio Shack COBOL's level of implementation as compared to the ANSI X3.23-1974 COBOL Standard.*


MICRO
MINT


AMP 206584-1 80-13



record can be accessed "at random" by specifying its record number. The first record is number 1, the second number 2, etc. The maximum length of a relative record is 253 bytes.

Indexed sequential access method (ISAM) files are the most powerful ones provided by RSCOBOL. Records in an ISAM file are fixed-length, but can be up to 4096 bytes long. When creating an ISAM file, one or more "keys" must be specified. A key is simply a field of the record that is used later as a search argument over the file.

For example, an employee record may contain a *Social Security* number field. If this field is specified as a key when the file is created, you can later retrieve a particular employee's record by specifying the Social Security number. Such a method is usually easier to program than relative files, which require that you provide a record's number in order to directly retrieve it.

When an ISAM file is created, records are stored in sorted order on their "primary keys." The primary key must be guaranteed unique; the Social Security number is a good example of such a field. Secondary keys can also be specified for a record. A record can be retrieved by specifying the value of any secondary-key field. Secondary keys can have duplicates, that is, two or more records can have the same value in a field designated as a secondary key.

The sample program in listing 1 uses a sequential-type file, not ISAM. It does a sequential search of the file when looking for a record whose key field matches the value typed in at the keyboard. If an ISAM file had been used, the record desired could have been located directly by its key value.

In summary, the records of an ISAM file can be sequentially retrieved in the sorted order of any key field, and directly retrieved by specifying the value of a particular key field. This powerful access method reduces the amount of user programming required for many data-storage applications.

ISAM files do pay a space penalty for this generality in retrieving

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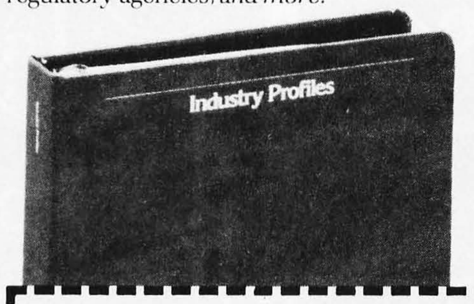
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records. An index structure is stored in the file for each field specified as a key. The manual states that the use of secondary (ALTERNATE) keys causes a geometric growth in the time required to create a file. However, the time required to access a record by its key is relatively uniform throughout the file.

The RSCOBOL manual gives the following formula for estimating the number of 256-byte sectors required for an ISAM file with the specified parameters:

NRECS=INT ((S+33)/32)×R/8
+(R×2)/INT (252/(Kn+8)) For each key
+(R×D)/8 If duplicates are allowed

where R=maximum number of records desired
S =size of records in bytes
Kn =size of key n in bytes
D =number of keys that allow duplicates

I created an ISAM file containing one hundred 61-byte records, each containing a 5-byte primary key and no secondary keys. The input records used to create the file were read from a sequential file on disk. The ISAM file took 3 minutes and 40 seconds to create (2.2 seconds per record), and it used 37 sectors on the disk (8 grans). Since the formula predicts 35.5 sectors, it appears to be fairly accurate. A record file created by Disk BASIC would take 25 sectors (four records per sector) to hold this same amount of data. Therefore, the indexes do produce some overhead. Of course, you could not access the Disk BASIC records by key value, and this is the function you are buying with this extra disk space.

Performance wise, the disks kept spinning the whole time the ISAM file was being generated. An interpreted BASIC program creating a record file usually leaves the disks idling at intervals while it is performing computations. Two factors could further speed up the file creation process. First, TRSDOS 2.3B steps my MPI disk-drive heads at a slow 40 milliseconds (ms) per track; they are capable of 5 ms per track. Second, I had the file of input records used to create the ISAM file on the same drive as the ISAM file itself. By placing these two files on separate drives, less disk-head movement would occur and the files would be accessed faster.

Documentation

The manual accompanying RSCOBOL is a substantial one. It comes in a 3-inch-thick loose-leaf binder containing 368 offset-printed pages in a readable dot-matrix font. This is definitely not a beginner's guide; a good COBOL textbook is a necessity if you have not used the language much. If you are already familiar with COBOL, however, you will find complete information about every aspect of RSCOBOL, written in the style of a reference manual.

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B3

The first section describes the use of the system, including discussions on how to use the compiler, the run-time module, and the interactive debugger. Compile-time and run-time error messages are listed and explained. An appendix gives sample program listings, including one that demonstrates many error messages. The source code for these sample programs is included on the disk that comes with the system.

The second section of the manual describes CEDIT. Several examples are given for each command. You should have no problems using the editor based on these instructions.

The third section is by far the largest at 297 pages. It gives a thorough definition of the RSCOBOL language, with detailed semantics for every language feature. The organization of the parts discussing file I/O is nicely divided into sections on sequential, relative, and indexed files.

There is a good table of contents, but no index is provided. Every error message the system can produce is documented with a sentence or two of descriptive text. There is an appendix listing all the COBOL reserved words. A thorough 24-page glossary describes special terms. The last appendix gives a skeleton description of the complete language syntax.

Conclusions

Radio Shack has provided a very complete, professionally done COBOL package. The memory-management options do almost everything possible to compensate for the inherent limits of the Model I and III machines—a small main memory of 48K bytes and limited floppy-disk storage. The most powerful features of this system, especially the multi-keyed ISAM files, are limited by the floppy-disk system for anything but the smallest applications. Use the formula given earlier for computing disk-space requirements and make sure your application will fit before you invest in this software. However, if you just want to learn how to program in COBOL and you already have the hardware, this is an excellent package. ■

Hardware Review

John Bell Engineering's Apple II Parallel Interface Board

Ned W. Rhodes
2001 North Kenilworth
Arlington, VA 22205

One reason I bought an Apple II was the potential for expansion on its motherboard. I'd planned to add a parallel I/O (input/output) port, a real-time clock, and a couple of other items I was going to design and build. After working with the board for two years, though, I concluded that buying one that already had these features would put me ahead of the game.

Fortunately, I discovered that John Bell Engineering produces an Apple II parallel interface board—actually a multifunction module. It contains two 6522 Versatile Interface Adapters (VIAs) and can function as a parallel interface, clock, or counter. To explain the capabilities of the card, I need only elaborate on the capabilities of the 6522 chip.

About the Author

Ned Rhodes earned a BEE from the University of Minnesota and a master's in computer science from George Washington University. He presently develops minicomputer-based distributed processing systems for the MELPAR division of E-Systems Inc. in Falls Church, Virginia.

The 6522 VIA

The 6522 is a 40-pin support chip compatible with the 6502 microprocessor family. The chip is designed for connection to the data and address bus of a 6502 microprocessor, and it provides two bidirectional, 8-bit I/O ports (where the direction of each bit is programmable). In addition to the parallel ports, each 6522 has two 16-bit, fully programmable clocks that can be used as counters or interval timers. The chip also includes a shift register for use with one of the timers to clock serial data into or out of the 6522. Each 6522 fully supports the 6502 interrupt structure, finally allowing you to constructively use

At a Glance

Name
Apple II Parallel Interface

Use
Board may be used for parallel I/O, timing, or serial-to-parallel/parallel-to-serial conversions

Manufacturer
John Bell Engineering
POB 338
Redwood City, CA 94064
(415) 367-1137

Dimensions
3 inches by 5 (7.5 by 12.5 cm); plugs into any Apple slot

Price
Assembled, $69.95; kit, $59.95; board only, $22.95

Features
Board contains two 6522 Versatile Interface Adapters with a total of four 8-bit, bidirectional I/O data ports; eight I/O control lines; four independent, 16-bit timers; and two 8-bit, serial-to-parallel/parallel-to-serial shift registers. User can choose the IRQ or NMI interrupt lines

Software Needed
All user-written—no software provided

Documentation
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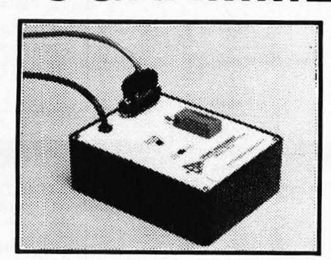
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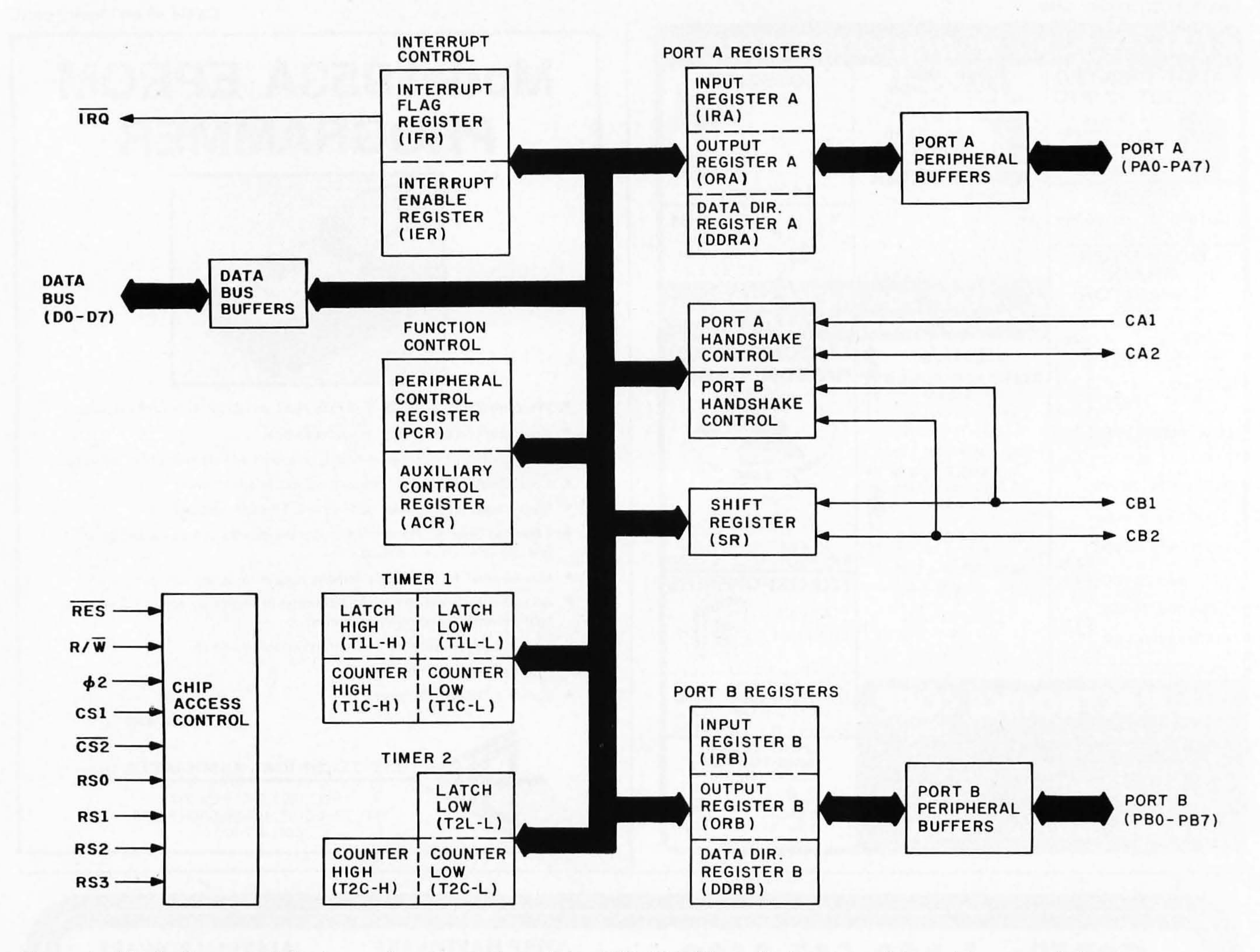


Figure 1: *Block diagram of the internal configuration of the 6522 VIA (Versatile Interface Adapter) integrated circuit.*

the Apple interrupts.

All communication with the 6522 occurs through 16 internal registers. Two of the 16, IRB/ORB and IRA/ORA, are used as I/O registers for the two 8-bit parallel ports. Two others, DDRB and DDRA, are data-direction registers that define the direction of each bit (either input or output) of the parallel ports. Four registers are set aside to control the two programmable counter/timers, and one I/O register controls the serial-shift register. Two registers select the operating mode of the timers and shift register; they also determine whether the chip will recognize positive- or negative-going control pulses.

The 6522 has a dedicated interrupt flags register that allows the chip to generate interrupts upon detection of (1) a positive- or negative-going edge on any of the four control lines, (2) a timeout (overflow) condition on either of the timers, or (3) the completion of a shift-register shift cycle. One register selectively enables and disables interrupt generation, while the last register is reserved for special forms of I/O through port A. Figure 1 is a block diagram of the 6522 chip's internal layout.

6522 on the Apple

Due to a design limitation in the Apple II, the 6522 can't work properly if it's merely attached to the bus; the 6522 requires a phase 2 clock pulse that isn't available on the Apple. The Apple 6502 processor generates the phase 2 clock signal, but that pin is unavailable at the expansion slot connectors.

Therefore, the I/O board must generate its own phase 2 clock signal. The phase 2 clock pulse is simulated by delaying the phase 0 clock signal by 80 nanoseconds. I must point out that simply delaying phase 0 may not match the duty cycle specification of the phase 2 clock, but that doesn't seem to matter. The 6522s accept the simulated phase 2 clock signal and work just fine.

The Circuit Board

The board may be purchased in three different forms. For those of you with no hardware experience, it's available as a fully assembled and tested card. It may also be bought as a complete kit or as a bare board for which you supply the parts. I chose the bare board, then ordered the sockets and 6522 chips from a mail-order supplier.

The board is very simple to build.

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All you do is mount two 40-pin sockets, four 16-pin sockets, one 14-pin socket, and two bypass capacitors. Then plug in the chips and you're ready to go. The documentation suggests that you use "standard assembly and soldering techniques." I guess that means you shouldn't lift the solder donuts by applying excessive heat and that solder bridges between pins are taboo. I managed to avoid both perils.

Connections are made through the four 16-pin DIP (dual in-line package) sockets; each socket handles eight bits. If interrupts are used, two jumper wires must be installed to enable them. One of the 6522s can be attached to the IRQ (interrupt-request) line, while the other can be attached to the NMI (nonmaskable interrupt) line. Note that the interrupt lines *cannot* be shared—you can have only one 6522 attached to an interrupt line.

Documentation accompanying the board is sparse, and the unadventurous user may get lost. The board comes with a two-page circu diagram and register identificati list, a two-page circuit descriptio and a two-page list of all possib board addresses (whose availabili depends upon which slot is used the Apple). A ten-page 6522 da sheet is also provided.

If you can read the data sheet, y can use the 6522. If you find the da sheet difficult to understand, chanc are this product isn't for you. T manufacturer has provided no so ware examples because of "t numerous uses of the board." believe that limits the boar usefulness. Hold on, though; I've pr vided two software routines demonstrate the capabilities of t parallel interface board and t 6522s.

Software

I was unable to write software th would test *all* of the 6522 functio so I chose two of the more comm applications: parallel I/O and clock

Parallel Printer Routine. The fi software example, in listing 1, is parallel output routine for a print such as the Epson MX-80. Two bas sections comprise the routine. In t first section, the output routine "hooked" through DOS, so that a character output to the screen w also appear on the printer. T horizontal-tab counter and t screen-echo flag are initialized at t time. The 6522 is then set up for o put, and a Control X is sent to t printer, clearing its internal buffer. the routine's second sectio characters are output, one at a tir to the printer.

The 6522 initialization is uniq First, you enable port A for output placing a hexadecimal FF in the da direction register (DDRA) for port Then set up the data-output stro and the data-ready flag, which are handshaking signals required parallel communications. When printer is ready to receive data, it dicates this with a pulse. With MX-80, a negative-going pulse dicates ready, so you tie it to the C line (one of the control lines for p A). The other signal, the data stro

Text continued on page

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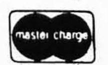
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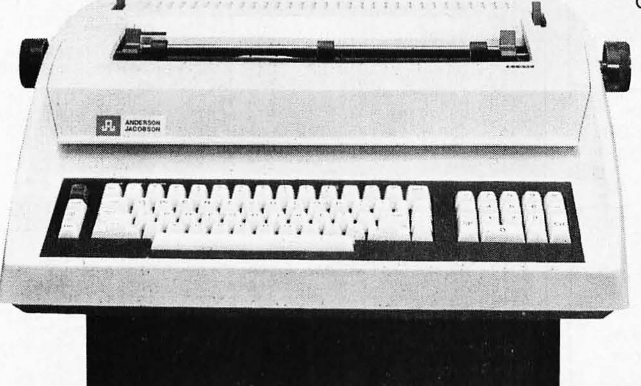
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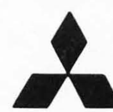
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Listing 1: *Parallel printer output routine for the John Bell Engineering parallel board. Written in 6502 assembly language, this program is designed to drive an Epson MX-80 printer.*

```
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               *
               * MX-80 PRINTER DRIVER
               *  DJG 3/81
               *  MODIFIED BY NWR FOR USE WITH JOHN BELL CARD
               *
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               * CNTL-H (BACK ARROW) ABORTS SCREEN ECHO SO
               * BASIC LISTINGS WILL USE FULL 80 COLUMNS
               * CNTL-G (BELL) IS ALWAYS SENT TO SCREEN ONLY
               *
               *
               *     6522 REGISTER EQUATES
               *
               *
C300-            SLT1 .EQ $C300     SLOT 3 6522 REGISTERS
C301-            ORA  .EQ SLT1+1    OUTPUT REGISTER A
C303-            DDRA .EQ SLT1+3    DATA DIRECTION REGISTER
C30C-            PCR  .EQ SLT1+$C   PERIPHERAL CONTROL REGISTER
C30D-            IFR  .EQ SLT1+$D   INTERRUPT FLAG REGISTER
               *
               *
               *     PROGRAM EQUATES
               *
               *
0024-            CH   .EQ $24      SCREEN HOR. CURSOR POSITION
0479-            HCNT .EQ $0479    CHARACTER COUNTER IN SLOT 1 RAM
04F9-            FLAG .EQ $04F9    FLAG FOR ECHOING ON SCREEN
0579-            ACC  .EQ $0579    ACCUMULATOR STORAGE
0011-            ENBL .EQ $11      ENABLE PRINTER CHARACTER
0098-            CNTX .EQ 152      CONTROL X CHARACTER
FDF0-            SCRN .EQ $FDF0    SCREEN SUBROUTINE
0036-            DHOK .EQ $36      OUTPUT HOOK LOCATION
03EA-            HOOK .EQ $3EA     DOS HOOK ROUTINE
0087-            BELL .EQ $87      BELL CHARACTER
0008-            SLNT .EQ $8       CONTROL-H  ECHO ON PRINTER ONLY
000D-            CAR  .EQ $D       CARRIAGE RETURN
00A0-            SPAC .EQ $A0      SPACE CHARACTER
               *
               *
                      .OR $0300    START IT HERE
                      .TF MX80.BELL.OBJ
               *
               *
               *     MX80 INITIALIZATION
               *
               *     CALL THIS PORTION OF THE ROUTINE TO
               *     SET UP THE PRINTER DRIVER TO SEND
               *     CHARACTERS TO THE PRINTER
               *
               *
0300- A9 FF      MX80 LDA #$FF     SET PORT A FOR
0302- 8D 03 C3        STA DDRA     OUTPUT
0305- A9 0A           LDA #$0A     CA1 ON NEGATIVE EDGE
0307- 8D 0C C3        STA PCR      CA2 GIVES PULSE
030A- A9 11           LDA #ENBL    ENABLE PRINTER (SO IFR1 WILL
030C- 8D 01 C3        STA ORA      BE SET FOR FIRST CHARACTER)
030F- A9 98           LDA #CNTX    CNTL X ERASES BUFFER
0311- 8D 79 05        STA ACC      SAVE IT
0314- 20 69 03        JSR POUT     SEND IT
0317- A9 2B           LDA #PRNT    ADDRESS OF NEW OUTPUT ROUTINE
0319- 85 36           STA DHOK     SAVE IT
031B- A9 03           LDA /PRNT    ADDRESS OF NEW OUTPUT ROUTINE
031D- 85 37           STA DHOK+1   SAVE IT
031F- 20 EA 03        JSR HOOK     HOOK NEW OUTPUT ROUTINE TO DOS
0322- A9 00           LDA #00      GET INITIAL VALUE
0324- 8D 79 04        STA HCNT     ZERO HORIZONTAL CHARACTER POSITION
0327- 8D F9 04        STA FLAG     SCREEN ECHO ON
032A- 60              RTS          DONE WITH INITIALIZATION
               *
               *
               *     OUTPUT ROUTINE
               *
               *
032B- C9 87      PRNT CMP #BELL    A BELL CHARACTER??
032D- F0 36           BEQ TV       YES, AVOID PRINTER'S RACKET
032F- 29 7F           AND #$7F     REMOVE MSB
0331- 48              PHA          SAVE ACCUMULATOR
0332- C9 08           CMP #SLNT    DISABLE SCREEN ECHO??
0334- D0 03           BNE CR       NO
0336- 8D F9 04        STA FLAG     PUT NON-ZERO IN FLAG
0339- C9 0D      CR   CMP #CAR     CARRIAGE RETURN?
033B- D0 05           BNE TAB      NO
033D- A9 FF           LDA #$FF     COUNTER WILL BE ZERO AFTER CR
033F- 8D 79 04        STA HCNT     RELOAD HORIZONTAL CHARACTER-1
0342- AD 79 04   TAB  LDA HCNT     COMPARE COUNTER WITH SCREEN
0345- C5 24           CMP CH       HOR. POSITION
0347- B0 0B           BCS CHAR     BRANCH IF IN PROPER POSITION
               *
               *
               *     OUTPUT SPACES UNTIL PRINTER IS AT THE PROPER
               *     HORIZONTAL CHARACTER POSITION
               *
               *
0349- A9 A0           LDA #SPAC    GET A SPACE
034B- 8D 79 05        STA ACC      SAVE AS PRINT CHARACTER
034E- 20 69 03        JSR POUT     PRINT IT
0351- 4C 42 03        JMP TAB      CHECK HOR. POSITION AGAIN
0354- 68         CHAR PLA          GET CHARACTER
0355- 8D 79 05        STA ACC      SAVE AS PRINT CHARACTER
0358- 20 69 03        JSR POUT     GO PRINT IT
035B- AD F9 04        LDA FLAG     ECHO ON SCREEN?
035E- D0 08           BNE RET      NO
```

Listing 1 continued on page 422

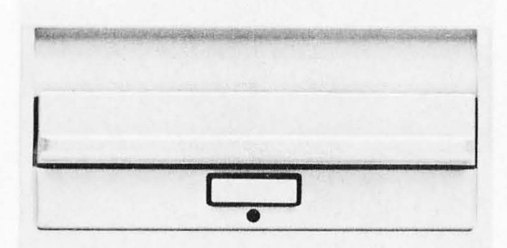
Circle 272 on inquiry card.



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Circle 314 on inquiry card.

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SN7402N	22	SN7492N	49
SN7404N	21	SN7493N	45
SN7408N	22	SN7495N	50
SN7410N	18	SN7496N	69
SN7412N	20	SN74122N	39
SN7413N	22	SN74136N	95
SN7414N	29	SN74141N	69
SN7416N	27	SN74151N	65
SN7417N	29	SN74153N	56
SN7420N	17	SN74154N	1 25
SN7425N	20	SN74155N	75
SN7430N	17	SN74157N	58
SN7437N	26	SN74160N	89
SN7438N	24	SN74161N	65
SN7440N	18	SN74163N	85
SN7442N	45	SN74164N	87
SN7443N	42	SN74165N	55
SN7445N	64	SN74174N	88
SN7451N	19	SN74175N	79
SN7454N	19	SN74180N	75
SN7474N	27	SN74181N	1 15
SN7475N	35	SN74393N	1 65

74S00

74S00	39	74S138	75
74S02	45	74S140	1 00
74S03	38	74S158	75
74S04	39	74S174	1 35
74S05	39	74S175	1 35
74S10	39	74S182	75
74S15	45	74S189	4 25
74S20	55	74S201	6 75
74S22	55	74S240	2 75
74S30	75	74S244	2 95
74S37	55	74S251	2 75
74S50	65	74S287	2 95
74S51	49	74S288	2 95
74S64	55	74S299	5 75
74S74	65	74S470	9 25
74S86	95	74S471	9 50
74S112	1 95	74S473	9 50
74S132	1 45	74S474	9 50

EPROMS

2708	3.25ea	8 for 2.95ea
2716	5.50ea	8 for 5.00ea
2732	12.95ea	4 for 11.00ea

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2114L 300NS	2.25ea	4 for	1.90ea
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2111 450NS	2.50ea	10 for	2.00ea

74LS00

74LS00	28	74LS158	69
74LS02	28	74LS161	83
74LS03	28	74LS162	89
74LS04	28	74LS163	98
74LS05	22	74LS164	65
74LS08	29	74LS165	66
74LS09	28	74LS169	1.55
74LS10	26	74LS170	1 75
74LS14	89	74LS174	85
74LS20	22	74LS175	85
74LS21	26	74LS190	85
74LS26	40	74LS191	1 25
74LS27	27	74LS196	95
74LS28	37	74LS197	78
74LS30	29	74LS221	1 25
74LS32	31	74LS240	1 65
74LS38	31	74LS241	1 65
74LS42	63	74LS243	1 55
74LS48	77	74LS244	1 56
74LS74	38	74LS245	2 45
74LS75	55	74LS251	1 25
74LS86	45	74LS253	85
74LS90	59	74LS257	85
74LS93	65	74LS259	1 95
74LS96	80	74LS260	55
74LS107	43	74LS273	1 55
74LS113	45	74LS279	45
74LS122	45	74LS290	1 25
74LS123	89	74LS293	1 65
74LS125	89	74LS365	85
74LS126	79	74LS367	75
74LS138	64	74LS373	1 45
74LS139	59	74LS374	1 45
74LS151	49	74LS377	1 25
74LS153	49	74LS669	1 55
74LS157	69	74LS670	1 85

MISC. cont'd

2102 450NS	.95	1103A	.75
8038	2.95	UPD765 floppy disk controller	19.85 w/spe
NE555	.27	ULN2001	1.95
AY5-1013A	4.25	TMS4400	1.40
1488	.95	MC4008P	1.50
1489	.95	MH0026	1.55
8T26	1.30	D3624	1.95
8T28	1.30	D3001	1.95
8212	1.95	D3002	1.95
8216	1.95		
IS410SCR	.85		
IT410TRIAC	.85		
7905	.85		
7908	.85		
7915	.85		
7918	.85		
7805	.85		
7806	.85		
7808	.85		
7812	.85		
MC1330A1P	1.60		
MC1350P	1.15		
MC1358P	1.50		
LM380	1.10		
LM565N	.95		
LM741	.25		
MC1458P	.55		

I.C. SOCKETS

ww	p	st
	8	10/1.20
10/5.30	14	10/1.30
10/5.70	16	10/1.40
10/8.70	18	10/1.80
10/9.70	20	10/2.70
10/12.70	22	10/2.70
10/13.70	24	10/2.70
10/14.70	28	10/3.00
10/17.70	40	10/3.90
wirewrap		solder

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8085A	13.50
2901A	7.50
MC6800	9.50

Circle 106 on inquiry card.

Listing 1 continued:

```
0360- AD 79 05          LDA ACC         GET CHARACTER AGAIN
0363- 09 80             ORA #$80        SET MSB FOR SCREEN
0365- 4C F0 FD     TV   JMP SCRN        OUTPUT TO SCREEN
0368- 60           RET  RTS             NORMAL RETURN
                   *
                   *
                   *    POUT SUBROUTINE
                   *
                   *    HANDLES OUTPUT TO PRINTER
                   *    CHARACTER TO BE PRINTED IS IN ACC
                   *
                   *
0369- A9 02        POUT LDA #02         LOAD COMPARE MASK
036B- 2C 0D C3          BIT IFR         IS PRINTER READY??
036E- F0 F9             BEQ POUT        NO, WAIT
0370- AD 79 05          LDA ACC         GET CHARACTER TO PRINT
0373- 8D 01 C3          STA ORA         PRINT IT
0376- EE 79 04          INC HCNT        BUMP CHAR. COUNTER
0379- 60                RTS             RETURN
                        .EN

SYMBOL TABLE

0579- ACC
0087- BELL
000D- CAR
0024- CH
0354- CHAR
0098- CNTX
0339- CR
C303- DDRA
0036- DHOK
0011- ENBL
04F9- FLAG
0479- HCNT
03EA- HOOK
C30D- IFR
0300- MX80
C301- ORA
C30C- PCR
0369- POUT
032B- PRNT
0368- RET
FDF0- SCRN
0008- SLNT
C300- SLT1
00A0- SPAC
0342- TAB
0365- TV
```

Listing 2: *This routine uses the parallel board as a real-time clock. The time will be continuously displayed on the screen.*

```
*** SYNTAX ERROR
:ASM

*
*
*       DOSCLOCK -- REAL TIME CLOCK WITH CORRECTION
*       FOR DISK USE.  THIS PROGRAM USES THE JOHN BELL
*       ENGINEERING PARALLEL BOARD AS A REAL TIME DIGITAL
*       CLOCK.
*
*       NOTE -- THIS ROUTINE IS ASSEMBLED TO START NEAR
*       THE END OF THE INPUT LINE BUFFER.  THIS MEANS THAT
*       YOU WILL NOT BE ABLE TO ENTER REALLY LONG LINES
*        OF TEXT.  THIS ROUTINE IS NOT COMPATABLE WITH
*       THE PROGRAM LINE EDITOR BECAUSE THAT PROGRAM USES
*       LOCATION $45 WHICH IS WHERE THE MONITOR STUFFS
*       THE ACCUMULATOR DURING INTERRUPT PROCESSING.
*
*       BECAUSE THE 6522 IS ATTACHED TO THE APPLE
*       BUSS, THE PUSHING OF THE RESET BUTTON WILL RESET THE
*       6522 AS WELL AS THE APPLE.  THAT MEANS THAT YOU WILL
*       HAVE TO RESTART THE CLOCK EVERY TIME RESET IS PUSHED.
*
*       IN ORDER TO USE THIS ROUTINE WITH THE JBE BOARD, YOU
*       HAVE TO ENABLE TIMER T2 TO COUNT THE NUMBER OF TICKS
*       OF TIMER T1.  THIS IS ACCOMPLISHED BY JUMPERING PINS
*       7 AND 8 ON J2 TOGETHER
*
*
*
* RAM VERSION FOR SLOT 3
*
*   DJG  4/81 (DERIVED FROM AN AIM CLOCK ROUTINE
*              BY DEJONG IN MICRO)
*   NWR  8/81 (MODIFIED FOR SLOT 3 AND THE
*              JBE PARALLEL BOARD)
*
*
* PROGRAM ADDRESSES:
*
*     ENTRY POINT (TO START CLOCK):
*         $0280        (CALL 640)
*
*     TO CONTROL SCREEN TIME DISPLAY:
*         $77F         (POKE 1919,X)
*         (NON-ZERO VALUE DISPLAYS TIME CONTINUOUSLY)
*
*     TO STOP CLOCK:
*
*      LOAD LOCATION $C30E WITH $40
*      (POKE -15602,64)
*
*
```

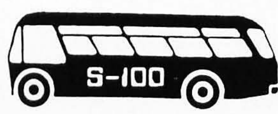
Listing 2 continued on page 424

Listing 2 continued:

```
                *      PROGRAM EQUATES
                *
                *
0045-           ACC   .EQ $0045    MONITOR SAVE ACC HERE ON IRQ
0420-           SCRN  .EQ $0420    RIGHT HAND TOP LINE OF SCREEN
047F-           FREE  .EQ $047F    SLOT 7 SCRATCH RAM -- SEE APPLE REFERENCE MANUAL
047F-           FRAC  .EQ FREE     INTERRUPT COUNTER
04FF-           SEC   .EQ FREE+$80  SECONDS COUNTER
057F-           MIN   .EQ FREE+$100 MINUTES COUNTER
05FF-           HOUR  .EQ FREE+$180 HOURS COUNTER
067F-           TMPL  .EQ FREE+$200 TEMP STORAGE
06FF-           TMPH  .EQ FREE+$280 TEMP STORAGE
077F-           FLAG  .EQ FREE+$300 DISPLAY FLAG
03FE-           IRQV  .EQ $03FE      IRQ VECTOR
                *
                *
                *      6222 REGISTER EQUATES
                *
                *
C300-           DS1   .EQ $C300   SLOT 3 6522 ADDRESSES
C300-           PB    .EQ DS1     PORT B
C304-           T1L   .EQ DS1+4   TIMER 1 LOW LATCH
C305-           T1H   .EQ DS1+5   T1 HIGH
C309-           T2L   .EQ DS1+8   TIMER 2 LOW LATCH
C309-           T2H   .EQ DS1+9   T2 HIGH
C30B-           ACR   .EQ DS1+$B CONTROL REG
C30D-           IFR   .EQ DS1+$D INTERRUPT FLAGS
C30E-           IER   .EQ DS1+$E INTERRUPT ENABLE
                *
                *
                      .OR $0280  START IT HERE
                      .TF DOSCLOCK.BELL.OBJ
                *
                *
                *      CLOCK ENTRY POINT
                *
                *
                *      SET UP IRQ VECTOR AND START THE CLOCK
                *
                *
0280- 78        CLOK SEI          DISABLE IRQ
0281- A9 B0           LDA #ISR    ADDRESS OF INTERRUPT SERVICE ROUTINE
0283- 8D FE 03        STA IRQV    SAVE IN IRQ
0286- A9 02           LDA /ISR    LAST HALF OF ADDRESS
0288- 8D FF 03        STA IRQV+1 SAVE IT
                *
                *
                *      SET UP THE 6522
                *
                *
028B- A9 C0           LDA #$C0    ENABLE T1 INTERRUPT
028D- 8D 0E C3        STA IER     BY LOADING THIS LOCATION
0290- A9 E0           LDA #$E0    T1 FREE RUN MODE
0292- 8D 0B C3        STA ACR     AND T2 COUNTS PB6
                *
                *
                *      YOU CAN PLAY WITH THE VALUE IN T1L AND T1H TO
                *      CORRECT TIME INACCURACIES.
                *
                *
0295- A9 20           LDA #$20    SET T1 TO F920
0297- 8D 04 C3        STA T1L     WHICH IS 1/16TH OF
029A- A9 F9           LDA #$F9    A SECOND
029C- 8D 05 C3        STA T1H     START T1
029F- A9 08           LDA #$08    T2 OVERFLOWS AFTER 1 SECOND IF
02A1- 8D 08 C3        STA T2L     DOS TURNED OFF IRQ INTERRUPT
02A4- A9 00           LDA #00     $800 IS ONE SECOND
02A6- 8D 09 C3        STA T2H     T2 COUNTS T1
02A9- A9 F0           LDA #$F0    COUNT 16 INTERRUPTS
02AB- 8D 7F 04        STA FRAC    PRELOAD THE LOCATION
02AE- 58              CLI         ENABLE IRQ
02AF- 60              RTS         RETURN
                *
                *
                * INTERRUPT SERVICE ROUTINE
                *
                *
02B0- EE 7F 04  ISR   INC FRAC    BUMP COUNTER
02B3- D0 70           BNE UNDO    NOT A FULL SECOND
02B5- A9 F0           LDA #$F0    RESET INTERRUPT COUNTER
02B7- 8D 7F 04        STA FRAC    SAVE IT HERE
02BA- AD 00 C3        LDA PB      IF T1 HAS ALREADY TICKED
02BD- 10 03           BPL TOUT    WE HAVE TO ADD
02BF- EE 7F 04        INC FRAC    ONE TO THE COUNT
02C2- A9 20     TOUT  LDA #$20    GET MASK
02C4- 2C 0D C3        BIT IFR     T2 TIMED OUT??
02C7- D0 62           BNE CORR    NO
02C9- A9 08           LDA #$08    RESET T2 COUNTER
02CB- 8D 08 C3        STA T2L     WITH A $800
                *
                *
                *      INCREMENT THE SOFTWARE CLOCK
                *
                *
02CE- EE FF 04  SECS INC SEC      BUMP SECONDS
02D1- AD FF 04        LDA SEC     GET CURRENT SECONDS
02D4- C9 3C           CMP #60     60 SECONDS??
02D6- 90 23           BCC SHOW    NO
02D8- A9 00           LDA #00     RESET SECONDS
02DA- 8D FF 04        STA SEC     TO ZERO
02DD- EE 7F 05  MINS INC MIN      BUMP MINUTES
02E0- AD 7F 05        LDA MIN     GET CURRENT MINUTES
02E3- C9 3C           CMP #60     60 MINUTES??
02E5- 90 14           BCC SHOW    NO
02E7- A9 00           LDA #00     RESET MINUTES
02E9- 8D 7F 05        STA MIN     TO ZERO
02EC- EE FF 05  HRS   INC HOUR    BUMP HOURS
02EF- AD FF 05        LDA HOUR    GET CURRENT HOUR
02F2- C9 18           CMP #24     24 HOURS??
02F4- 90 05           BCC SHOW    NO
02F6- A9 00           LDA #00     RESET HOURS
02F8- 8D FF 05        STA HOUR    TO ZERO
                *
                *
                *      DISPLAY THE TIME IF DESIRED
```

Listing 2 continued on page

CATCH THE S-100 INC. BUS! *EXPRESS*



Move up to an 8MHZ 8086 Super System

System Support Board

1 serial/1 parallel port, 8 MHZ 8086 CPU (16 Bit Processor)
86 DOS Disk Operating System
Realtime Clock
Timers

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86 DOS Disk Operating System
64K byte (32k word) Static RAM (70 NS)
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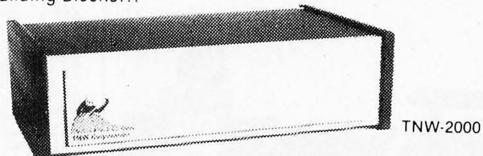
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The versatile ABUG monitor is a compact version of CBUG, tailored for debugging programs generated by the Assembler and Editor. It features examine/change of memory or registers, cassette load and save, breakpoints and more. **SDS80C Price: $89.95**

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MEMORY UPGRADE KITS: 4-16K Kit **Price $39.95**. 16-32K (requires soldering experience) **Price: $39.95**
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Listing 2 continued:

```
                   *
                   *
02FB- AD 7F 07     SHOW LDA FLAG     DISPLAY TIME??
02FE- F0 20             BEQ DONE     NO
0300- 8E 7F 06          STX TMPL     SAVE X
0303- 8C FF 06          STY TMPH     SAVE Y
0306- A2 00             LDX #00      CLEAR X
0308- AD FF 05          LDA HOUR     GET THE CURRENT HOUR
030B- 20 84 03          JSR DSPL     PRINT IT
030E- AD 7F 05          LDA MIN      GET CURRENT MINUTE
0311- 20 7C 03          JSR DCOL     PRINT IT
0314- AD FF 04          LDA SEC      GET CURRENT SECONDS
0317- 20 7C 03          JSR DCOL     DISPLAY IT
031A- AE 7F 06          LDX TMPL     RESTORE X
031D- AC FF 06          LDY TMPH     RESTORE Y
                   *
                   *
                   *      INTERRUPT DONE
                   *
                   *
0320- A9 00        DONE LDA #00      GET A ZERO
0322- 8D 09 C3          STA T2H      START T2
0325- AD 04 C3     UNDO LDA T1L      CLEAR INTERRUPT FLAG
0328- A5 45             LDA ACC      RESTORE ACCUM.
032A- 40                RTI          INTERRUPT RETURN
                   *
                   *
                   *      CORRECTION TO TIME WHEN DOS TURNED OFF IRQ
                   *
                   *
032B- 38           CORR SEC          SAVE 2'S COMPLEMENT OF T2
032C- A9 00             LDA #00      BY SUBTRACTING
032E- ED 08 C3          SBC T2L      FROM ZERO
0331- 8D 7F 06          STA TMPL     SAVE PARTIAL RESULT
0334- A9 00             LDA #00      ANOTHER ZERO
0336- ED 09 C3          SBC T2H      AND THE SUBTRACT
0339- 8D FF 06          STA TMPH     SAVE IT
                   *
                   *
                   *      DO THE CORRECTION
                   *
                   *
033C- AD 7F 06     SETF LDA TMPL     SET FRACTION
033F- 29 07             AND #$07     TO CORRECT
0341- 0A                ASL          1/16
0342- 6D 7F 04          ADC FRAC     OF A SEC
0345- 8D 7F 04          STA FRAC     SAVE IT BACK
0348- 29 0F             AND #$0F     CORRECT T2
034A- 4A                LSR          TO THE PARTIAL
034B- 49 FF             EOR #$FF     NUMBER OF
034D- 18                CLC          OF TICKS
034E- 69 09             ADC #$09     LEFT IN ITS INTERVAL
0350- 8D 08 C3          STA T2L      AND SAVE BACK
0353- 4E FF 06          LSR TMPH     DIVIDE BY EIGHT
0356- 6E 7F 06          ROR TMPL     TO GET NUMBER
0359- 4E FF 06          LSR TMPH     OF FULL SECONDS
035C- 6E 7F 06          ROR TMPL     TO ADD TO THE
035F- 4E FF 06          LSR TMPH     TIME TO CORRECT
0362- 6E 7F 06          ROR TMPL     FOR DOS BEING ON
0365- 18                CLC          SETUP THE CARRY
0366- AD FF 04          LDA SEC      ADD THE FULL
0369- 69 01             ADC #01      SECONDS
036B- 6D 7F 06          ADC TMPL     AND STORE IN
036E- 8D FF 04          STA SEC      SECONDS COUNTER
0371- 38                SEC          CHECK FOR GREATER
0372- E9 3C             SBC #60      THAN 60 SECONDS
0374- 90 85             BCC SHOW     TO SEE IF A MINUTE
0376- 8D FF 04          STA SEC      UPDATE IS
0379- 4C DD 02          JMP MINS     REQUIRED
                   *
                   *
                   * DISPLAY SUBROUTINE
                   *
                   *
037C- A8           DCOL TAY          SAVE COUNT
037D- A9 BA             LDA #$BA     GET A COLON
037F- 9D 20 04          STA SCRN,X   SHOW IT
0382- E8                INX          BUMP COUNTER
0383- 98                TYA          RESTORE COUNT
0384- A0 FF        DSPL LDY #$FF     DISPLAY TIME
0386- C8           CNTY INY          Y WILL COUNT BY 10
0387- 38                SEC          SET CARRY
0388- E9 0A             SBC #10      MINUS 10
038A- B0 FA             BCS CNTY     GET RID OF TENS
038C- 69 0A             ADC #10      RESTORE REMAINDER
038E- 48                PHA          AND SAVE
038F- 98                TYA          DISPLAY TENS DIGIT
0390- 09 B0             ORA #$B0     MAKE IT ASCII
0392- 9D 20 04          STA SCRN,X   SHOW IT
0395- E8                INX          BUMP X
0396- 68                PLA          GET ONES DIGIT
0397- 09 B0             ORA #$B0     MAKE IT ASCII
0399- 9D 20 04          STA SCRN,X   SHOW IT
039C- E8                INX          BUMP THE COUNT
039D- 60                RTS          RETURN
                        .EN
```

```
SYMBOL TABLE

0045- ACC      C30D- IFR      06FF- TMPH
C30B- ACR      03FE- IRQV     067F- TMPL
0280- CLOK     02B0- ISR      02C2- TOUT
0386- CNTY     057F- MIN      0325- UNDO
032B- CORR     02DD- MINS
037C- DCOL     C300- PB
0320- DONE     0420- SCRN
C300- DS1      04FF- SEC
0384- DSPL     02CF- SECS
077F- FLAG     033C- SETF
047F- FRAC     02FB- SHOW
047F- FREE     C305- T1H
05FF- HOUR     C304- T1L
02EC- HRS      C309- T2H
C30E- IER      C308- T2L
```



Text continued from page 418

clocks data into the printer's internal buffer. Again, the MX-80 requires a negative-going pulse for the data strobe; use control pin CA2 for this function.

The 6522 allows you to choose a negative- or positive-going pulse for either of two signals; inform the 6522 of the desired polarity by loading the Peripheral Control Register (PCR). With the MX-80, hexadecimal 0A is the proper code. This bit pattern is determined by consulting the coded values on the data sheet. We enable the printer by sending it a Control Q (hexadecimal 11) and then a Control X to clear the internal buffer.

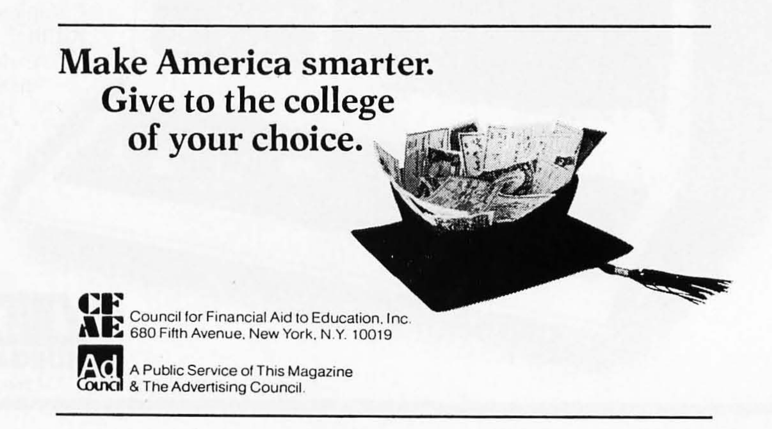
The actual output routine is quite simple. First, check the horizontal character position and compare it with the current character position in the output line. If they differ, output spaces until reaching the proper character position. To print characters, check bit 2 in the Interrupt Flag Register (IFR) to see if the printer has sent its data-ready flag. This bit will be set if the 6522 has detected a negative edge on control pin 1 (CA1), which is the ready line.

If the printer is busy or has yet to send the ready pulse, keep testing the bit until the printer is ready. When the printer is ready to receive data, store the character to be printed in the output register for port A. As you place the character in the output register, it's clocked into the printer's internal register because pin CA2 goes low and acts as the data strobe. The printer becomes busy while accepting the character. Once it's processed, the ready pulse is given and the printer will accept another character.

Time-of-Day Clock. Listing 2's routine is a time-of-day clock that continuously displays the time on the screen. The routine uses interrupts so that the clock runs while you develop and run BASIC programs. The routine is compatible with DOS 3.3; DOS disables the IRQ interrupt while it does I/O and then re-enables the interrupt when finished. (I haven't tried

Listing 3: *This BASIC routine will load and initialize the clock. It will also protect the time display.*

```
]PR#0
>LIST
  10 REM
  20 REM
  30 REM   ROUTINE TO LOAD AND START THE DOSCLOCK
  40 REM
  50 REM
  60 PRINT "BLOAD DOSCLOCK.BELL.OBJ"
  70 POKE 34,0: CALL -936
  80 PRINT "THE CURRENT TIME IS -- >": POKE 34,2
  90 VTAB 10
 100 INPUT "ENTER HH,MM,SS ",H,M,S
 110 POKE 1535,H: REM  HOURS
 120 POKE 1407,M: REM  MINUTES
 130 POKE 1279,S: REM  SECONDS
 140 CALL 640: REM  START THE CLOCK
 150 POKE 1919,1: REM  DISPLAY TIME
 160 END
```



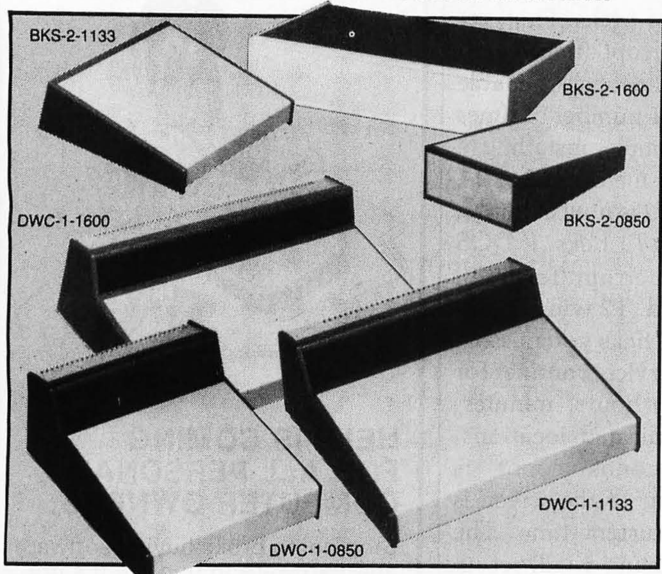
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the routine with earlier DOS versions. If you plan to, back up your disks in the event of failure.)

My method of implementing the clock involves both timers on one 6522 and a couple of tricks. First, set up timer T1 to interrupt (tick) every $\frac{1}{16}$ second. Simultaneously, enable timer T2 to count the number of times that T1 ticks by simply installing a jumper wire to feed the output of T1 to the input of T2. T2 is now counting the number of times T1 ticks. If DOS turns off the IRQ interrupt (for I/O), when it is re-enabled T2 will contain the number of clock ticks you missed.

The interrupt service routine for the clock keeps the hours, minutes, and seconds in dedicated locations. Whenever the seconds count is changed, the top line of the screen is updated with the current time. The BASIC routine in listing 3 will set up the current time of day and protect the top line. From then on, time will be displayed continuously. The clock routine can determine execution times of routines or schedule other events at certain times during the day. Because no two Apples have identical time bases, some correction factors may have to be used. The listing indicates where to apply those factors.

Conclusions

- The Apple parallel board may be used for all interfacing projects where parallel I/O is needed or where timing or counting is required.
- The board contains two 6522 support chips for input or output, timing or counting, and serial-to-parallel/parallel-to-serial operations.
- The board is available fully assembled, as a kit, or alone. The kit is easy to build, but you must be able to read a circuit diagram.
- Documentation is sparse, though all required information for use of the 6522 is included. The manufacturer does *not* hold your hand, relying instead on the user community to publish software that uses the board.
- The Apple parallel board is a good, inexpensive way to enhance the Apple with the power of the 6522 Versatile Interface Adapter. ■



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Books Received

Aircraft Electricity and Electronics, 3rd edition, Ralph D. Bent and James L. McKinley. New York: Gregg/McGraw-Hill, 1981; 359 pages, 27.5 by 20.5 cm, softcover, ISBN 0-07-004793-6, $19.95.

The Complete Problem Solver, John R. Hayes. Philadelphia, PA: The Franklin Institute Press, 1981; 255 pages, 25 by 17.5 cm, hardcover, ISBN 0-89168-028-4, $19.50.

The Computers Are Coming, Irv Brechner. Livingston, NJ: Irv Brechner (POB 453), 1981; 92 pages, 22.5 by 14.5 cm, softcover, ISBN none, $4.95.

Digital Circuits and Microprocessors, Herbert Taub. New York: McGraw-Hill, 1982; 541 pages, 23.5 by 16.5 cm, hardcover, ISBN 0-07-062945-5, $28.95.

The Electronic Cottage, Joseph Deken. New York: William Morrow and Company, 1982; 344 pages, 23.5 by 16 cm, hardcover, ISBN 0-688-00664-7, $14.95.

50 More Programs in BASIC for the Home, School & Office, 2nd edition, Jim Cole. Woodsboro, MD: Arcsoft Publishers, 1981; 96 pages, 21 by 13.5 cm, softcover, ISBN 0-86668-502-2, $9.95.

The Handbook of Artificial Intelligence, Volume 1, Avron Barr and Edward A. Feigenbaum, eds. Los Altos, CA: William Kaufmann, 1981; 409 pages, 23.5 by 15.5 cm, hardcover, ISBN 0-86576-005-5, $30.

Handbook of Semiconductor and Bubble Memories, Walter A. Triebel and Alfred E. Chu. Englewood Cliffs, NJ: Prentice-Hall, 1982; 401 pages, 23 by 18.5 cm, hardcover, ISBN 0-13-381251-0, $24.95.

How to Break into the Computer Field, L. Peter Carron. Easton, PA: L. P. Carron Publishers (205 Ridgewood Rd.), 1981; 138 pages, 22.5 by 14.5 cm, softcover, ISBN 0-9607242-0-6, $7.95.

Introduction to Microprocessors, Charles M. Gilmore. New York: Gregg/McGraw-Hill, 1981; 310 pages, 27.5 by 21 cm, softcover, ISBN 0-07-023301-2, $14.96.

Learning Digital Electronics Through Experiments, Edward J. Pasahow. New York: Gregg/McGraw-Hill, 1982; 215 pages, 22 by 14.5 cm, softcover, ISBN 0-07-048622-7, $8.95.

The Making of the Micro, A History of the Computer, Christopher Evans. New York: Van Nostrand Reinhold, 1981; 118 pages, 26 by 18.5 cm, hardcover, ISBN 0-442-22240-8, $14.95.

Mathematics into Type, revised edition, Ellen Swanson. Providence, RI: American Mathematical Society (POB 6248), 1979; 90 pages, 24.5 by 17.5 cm, softcover, ISBN 0-8218-0053-1, $12.40.

Murder in the Mansion, And Other Computer Adventures in Pocket-BASIC for the TRS-80, 2nd edition, Jim Cole. Woodsboro, MD:

Books Received

Arcsoft Publishers, 1981; 96 pages, 21 by 13 cm, softcover, ISBN 0-86668-501-4, $6.95.

Nonlinear System Theory, The Volterra/Wiener Approach, Wilson J. Rugh. Baltimore, MD: The Johns Hopkins University Press, 1981; 325 pages, 23 by 18.5 cm, hardcover, ISBN 0-8018-2549-0, $32.50.

Optimization: A Simplified Approach, William Conley. Princeton, NJ: Petrocelli Books, 1981; 248 pages, 23.5 by 15.5 cm, hardcover, ISBN 0-89433-121-3, $20.

Programs for Beginners on the TRS-80, Fred Blechman. Rochelle Park, NJ: Hayden Book Company, 1981; 150 pages, 17.5 by 24.5 cm, softcover, ISBN 0-8104-5182-4, $8.95.

Real Time Programming—Neglected Topics, Caxton C. Foster. Reading, MA: Addison-Wesley, 1981; 190 pages, 23 by 15.5 cm, softcover, ISBN 0-201-01937-X, $9.95.

RPG & RPG II Primer, A Modern Approach, H. Mullish and R. Kestenbaum. New York: Holt, Rinehart and Winston, 1982; 189 pages, 27.5 by 20.5 cm, softcover, ISBN 0-03-056918-4, $17.95.

Standard BASIC Programming for Business and Management Applications, James S. Quasney and John Maniotes. San Francisco, CA: Boyd & Fraser Publishing Company, 1980; 408 pages, 17.5 by 25 cm, softcover, ISBN 0-87835-081-0, $13.95.

VLSI Systems and Computations, H. T. Kung, Bob Sproull, and Guy Steele, eds. Rockville, MD: Computer Science Press, 1981; 415 pages, 23.5 by 16 cm, hardcover, ISBN 0-914894-35-8, $29.95.

Webster's Microcomputer Buyer's Guide, Tony Webster. Rochelle Park, NJ: Hayden Book Company, 1981; 326 pages, 26.5 by 21 cm, softcover, ISBN 0-9594624-2-2, $25.

Without Me You're Nothing: The Essential Guide to Home Computers, Frank Herbert and Max Barnard. New York: Pocket Books, 1981; 304 pages, 20.5 by 13 cm, softcover, ISBN 0-671-43964-2, $5.95.■

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

BYTE's Bugs

Inflated Bug

Joe Hadleman's inflation calculator program in the July 1981 BYTE has a bug in line 440, page 302. (See "Computing Inflation with the Consumer Price Index," page 300.) If:

```
STR$(P2-INT(P2))
```

is less than 0.01 (in other words, if the rounding error is less than a penny), the calculation is handled in scientific notation and the output is garbage. To correct this, insert:

```
OR IF (P2-INT(P2))<.01
```

before the "THEN" of line 430.

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News and Speculation about Personal Computing

Conducted by Sol Libes

Random Rumors: IBM is rumored to be increasing production of its personal computer system, with 175,000 units expected to be sold before Christmas 1982. IBM will probably soon announce a graphics package and X.25 communications options for the personal computer. . . . Epson America is expected to introduce several video terminals, including one with a flat screen. The rumor is that they will be shown at the NCC (National Computer Conference) in June; look for Sinclair, Sony, and Hitachi to introduce similar products at NCC. Also due at NCC are 80- and 160-megabyte 8-inch Winchester hard-disk drives from Micropolis and 16- and 30-megabyte 5¼-inch Winchesters from Control Data Corp. . . . Reportedly, a 15-inch flat-screen monitor is due from Japan shortly. . . . DEC (Digital Equipment Corporation) is expected to introduce a PDP-8 replacement, a 16-bit version of its recently introduced personal-computer board for the VT-100 terminal, and a complete personal computer. Incidentally, DEC is budgeting $500 million for research and development, with half going to software development and its 2000-member software development team. . . . Hearsay has it that Centronics is working on a ribbonless dot-matrix printer. . . . NEC (Nippon Electric Company) is supposedly about to introduce two new systems in the U.S., both of which are already on the market in Japan: the PC6000, a consumer-oriented machine, and the PC8800, an 8086-based machine for the business market. . . . Commodore is said to be working on a new version of the VIC computer for introduction early next year. The unit should have 256K bytes of memory and 80-column black and white or color video display. . . . Look for the upgrade of the Osborne-I to be introduced later this year. It's rumored to have an 80-character-wide display (versus the current 52-column unit), double-density floppy-disk drives, a built-in modem, and a communications package. A significant jump in price will probably accompany it. . . . Toshiba is also expected to introduce into the U.S. a product it's already selling in Japan—a Z80-based system that runs CP/M, T-Basic, and UCSD Pascal.

Random Bits: At the recent Comdex show held for dealers, emphasis changed from the hobbyist to a business orientation, with Apples and TRS-80s all but replaced by integrated business systems. This change should be reflected in computer stores shortly. . . . NEC, Toshiba, and Okidata Corporation are currently supplying samples of 256K-bit dynamic memory devices and expect to start volume delivery in June. These ICs should begin showing up in equipment by the middle of 1983. . . . S D Systems will introduce yet another local-network system called MARS/NET. . . . Mitsubishi is supplying samples of its 5¼-inch Winchester disk drives and half-wide floppy-disk drives; Toshiba is also considering sale of its 5¼-inch Winchester in the U.S. Shugart's half-height 5¼-inch SA210 floppy-disk drive will make its first appearance in Xerox's new Sabre line of electronic typewriters. . . . WD (Western Digital) is expected to shortly introduce a single-chip Winchester controller that replaces 25 TTL (transistor-transistor logic) parts. Also due from WD is a new floppy-disk drive controller IC that incorporates the data separator, comparator, and write-precompensation circuits missing from current controllers. . . . IBM recently opened its tenth computer store; more are in the works. . . . Seagate has introduced a 6-megabyte, 5¼-inch Winchester with removable media. . . . Emulog of Freemont, California, has introduced a full-feature video terminal with a $465 list price. . . . HP (Hewlett-Packard) has separated its personal-computer operation from the calculator division and created a Personal Computation Group. HP has also increased dealer discounts on models 80, 85, and 125 systems by as much as 25 percent over previous discounts. . . . Radio Shack has beaten Apple into the 16-bit market with the introduction of its new Model 16, 68000-based microcomputer. For more details on this machine and other new products, see page 40. Radio Shack has also established an online videotex-information data-base system for subscribers in the Forth Worth area.

Unix Royalty Fees Cut: Western Electric recently introduced its Unix System III update which combines Version 7 Unix and the PWB (Programmer's Workbench) into a single system. Some enhancements have also been added. They raised the source code license fee to $43,000 but lowered the distribution deposit from $50,000 to $25,000 against royalties. The royalty fees have been reduced to $100 for a single user and $250 for systems for 2 to 16 users. (Previously, a license cost $1500 plus $250 per user.)

Royalties prepaid under the old rates will not be refunded. Licensees will, in effect, start with a clean slate. Hence, Microsoft will lose the $200,000 it had prepaid to obtain a discount advantage, an advantage it no longer has.

The reduction in royalty fees removes what has been a significant deterrent for people wishing to use Unix, namely that it was very expensive. This should increase competition among Unix and its look-alikes. More important, it puts Unix in a much better position to compete with other single- and multiuser operating systems such as CP/M-86 and MP/M-86. Microsoft's president, Bill Gates, indicated that despite his unhappiness about the lost royalty payment, the royalty change would help his company sell copies of Xenix, its version of Unix.

Ada Update: Ada is finally becoming available as a working language. Telesoft Incorporated of San Diego, California, released its Ada package for 68000 systems last August, and RR Software of Madison, Wisconsin, in November released Janus, a

version for Z80 computers running CP/M. Both compile subsets of the Ada language. The Telesoft Ada compiler retails at $2400, while Janus sells for $250.

The DOD (Department of Defense) holds the trademark on the name "Ada" and stipulates that commercial companies can use the name only if they have or are developing a full-language compiler. To acquire legal access to the name "Ada," a company must submit its product to a DOD Ada-validation office for approval. Validation will ensure that programs written with the compiler will be fully portable between computers. Portability of that type doesn't exist for system-oriented languages such as Pascal, FORTH, and C.

Western Digital, based in Irvine, California, has also demonstrated its microAda and expects to be the first company to submit a complete Ada compiler to the DOD for validation. WD plans to submit it within the next 3 to 4 months. The WD Ada will run only on WD's new PAL 16-bit computer; a WD microAda license will cost $2000.

SuperSoft Associates of Champaign, Illinois, has demonstrated its Ada compiler for Z80 systems, also expected to be ready for submission to the DOD for validation sometime this year. SuperSoft intends to release Intel 8086/8088, Motorola 68000, and Zilog Z8000 versions, with the Z80 version to sell for under $300.

Telesoft is developing versions of its Ada compiler to run on the 8086, DEC VAX, and IBM 370 machines. Intel has developed an Ada compiler for its iAPX432 32-bit microcomputer currently running at beta test sites. Intel is preparing to submit the compiler for DOD validation.

And Ethernet's Fate? A report issued by Strategic Incorporated, a market-research firm in San Jose, California, predicts Xerox Corporation's Ethernet local-area network will be a total failure within two years. According to Strategic's president, Michael Killen, "Xerox is headed for the worst failure in the company's history." He believes that Xerox lacks technological and price advantages, sales force, and customers interested in buying large systems. Further, he contends that Ethernet's baseband approach to local networking will prove inferior over the long haul to the broadband approach taken by Xerox's competitors. He points out that broadband systems are better suited to carry video, heavy voice and data transmissions, among other applications.

In response to the report, Xerox issued the following statement: "Based on the level of customer satisfaction with our existing network installations, the backlog of orders for network products and service, and the interest in Ethernet on the part of major accounts, we are confident that Xerox will be a leading vendor in office automation."

Bell Set to Move Into Computer-Related Markets: AT&T (American Telephone and Telegraph) is undergoing a major management reorganization to comply with the FCC-required separation of regulated and deregulated activities. As a result, look for the Bell System to become an unbridled competitor in computer-related markets. It will probably begin marketing terminals and business computers soon, competing directly with companies such as IBM, Wang, Xerox, and DEC in the intelligent-terminal and work station markets and with Tymnet and Telenet in the communications-processing field. It is unlikely that Bell will compete directly with IBM in the mainframe business.

The Bell System itself presents a large, captive market for computer products. Actually, the Bell System is IBM's biggest customer outside of the U.S. government. Bell is expected to sell business and personal computers through its many Phone Center stores.

AT&T has also agreed to provide CBS (Columbia Broadcasting System) with home-computer terminals, data-entry equipment, and transmission facilities for a joint teletext experiment scheduled to begin this fall in New Jersey.

A National Amateur Computer Society: The Japan Microcomputer Club is well organized, registers close to 4000 members, and has chapters in every major city in Japan. Hobbyists in England also work together through one central organization, providing an excellent base for the computer industry.

Computer hobbyists have long been the backbone of technological growth, but in the U.S., the hobbyist community is fragmented into several hundred independent clubs. A handful of clubs have over 1000 members, but most include fewer than 100. While some attempts have been made to found a national organization, none has succeeded.

Personal computing as a hobby is a breeding ground for computer professionals of tomorrow. Therefore, it's vital that we organize a national amateur computer society while we are still the world's technological leader in computing.

CP/M Goes Into Firmware: Digital Research has signed an agreement with Intel which will allow the latter to sell ROMs encoded with the CP/M-86 operating system. The ROM will also contain timers and some logic; it should be available by mid-year. The ROM is intended for use in a CP/net system where systems containing CP/M in firmware don't have any disk but must communicate with a CP/M or MP/M server.

Intel will also sell CP/M-86 and MP/M-86 on disk for its single-board and 86/330 system. Intel has contracted with Microsoft for its MS-DOS (used on the IBM personal computer). Intel will sell its own RMX-86 DOS and plans to acquire Unix from Western Electric. Hence, Intel users and systems houses will be able to select among a wide variety of operating systems. Intel also expects to market applications software.

Digital Research Buys MT Microsystems: Digital Research has acquired its second software company in less than three months by purchasing MT MicroSystems Incorporated of San Diego, California, supplier of Pascal/MT. Previously, Digital Research had purchased Compiler Systems Incorporated, supplier of CBasic.

Exxon Buys Out Zilog: Over the years, Exxon Corporation has moved from a minor investor in Zilog Incorporated, supplier of the Z80, to a major investor, owning

90 percent of the stock. Zilog has bought the remaining 10 percent and will become a wholly owned Exxon subsidiary. One result is that Exxon will no longer be required to break out Zilog's quarterly earnings for shareholders. Zilog, incidentally, has yet to report a profit. In fact, the Exxon Enterprises operation, which includes all of Exxon's electronics subsidiaries, incurred a loss of $51 million in the first nine months of 1981.

Microprocessor Trends: Did you know that there are currently 51 different general-purpose microprocessors in production, that 17 are 4-bit devices, 14 are 8-bit devices, 6 are 16-bit devices, 4 are 32-bit devices with 16-bit I/O, 4 are bipolar, and 5 are microframe or special (e.g., Intel iAPX432)? Futher, did you know that seven more have been announced but are not yet in production, and that 42 companies currently manufacture microprocessors?

The microprocessor recently celebrated its tenth birthday. Credit for creating the microprocessor goes to Intel. (See this month's Editorial on page 6.) Ten years ago, the companies that designed micros were mostly small, freewheeling organizations employing a great deal of ingenuity. Today, it is a totally different ballgame. Most of those early pioneers were either swallowed up by large companies (e.g., Zilog and MOS Technology) or are now very large companies (e.g., Intel, AMD, and National Semiconductor). Furthermore, leadership in design and production appears to be passing to the Japanese.

The microprocessor scene has changed a lot over these ten years. The question now is: what are the current trends and directions of the new micros? First of all, suppliers are making micros easier to program. National and Zilog already have micros with software-in-silicon. They each provide single-chip computers that execute BASIC statements directly in an interpretive mode. Futhermore, Intel is developing one micro with the capability to execute MP/M and another with a sophisticated on-board operating system. Also, there are rumors of a one-chip FORTH computer. There's no doubt that both National and Zilog have been successful with BASIC-processing ICs.

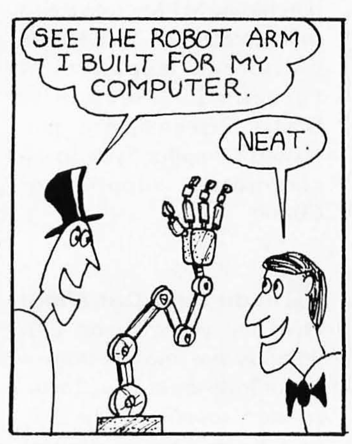
Second, microcomputer ICs are getting more sophisticated, having floating-point capability, multiply/divide functions, enhanced interrupt handling, and the like.

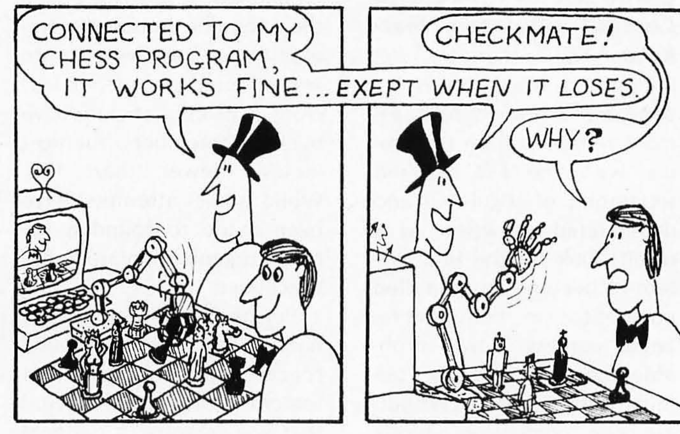
The most glamorous changes will occur in the 16/32 bit micros. All of these devices are getting coprocessors to extend their capabilities into the minicomputer field. Incidentally, Zilog has disclosed that it's working on a 32-bit micro. If the 8-bit unit is a Z80, the 8/16-bit device is a Z800, and the 16-bit micro is the Z8000, what will its 32-bitter be called? You guessed it! The Z80000! Maybe Zilog would be better off calling it the $Z8 \times 10^4$.

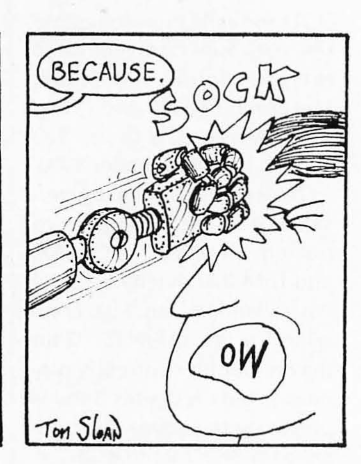
Memory Trends... or, What Is Turbo and Parity? I occasionally look back with fondness to my first micro. It had 256 bytes of memory and used an Intel 8008. That was only 8 years ago. The next year, I graduated to an Altair 8800 that had an 8080, six printed-circuit cards containing 4K bytes of RAM, an I/O channel, and a huge power supply. How times have changed!

The most significant change has been in memory. Today the 16K-bit, single-voltage RAMs dominate the marketplace, providing cost savings (mostly by shrinking power-supply requirements), yielding faster operation, and making the 64K-byte computer memory nearly standard. The 64K-bit RAM ICs are just starting to appear, and we find that computer memory sizes of 128K bytes and 256K bytes are becoming more common and will probably become the standard microcomputer memory size by the end of 1983. The 256K-byte RAM chips are now going into production. I expect that by 1985 1 megabyte will probably be the typical microcomputer memory size. Also, as the volumetric memory space decreases, the associated access time decreases, resulting in increased system performance.

Some of the most interesting changes in memory design are improving memory reliability and speed. Memory manufacturers are beginning to introduce multifunction memory systems that perform parity or error-checking and correction functions previously handled by a computer's processor, if they were done at all. In fact, National







Semiconductor has introduced an IC (the DP8400) that performs all the memory error checking and correcting so that the processor is not bothered with this task. Error checking and correction is particularly important with dynamic RAM since these devices are prone to soft (transient) errors due to noise and radio-frequency interference, alpha particles, cosmic rays, and voltage fluctuations.

Manufacturers are also introducing on-board batteries to protect RAM during power failure. With the use of CMOS RAM, an on-board battery can protect data for over a hundred hours, and lithium-iodine batteries have been shown to be able to provide as much as one year of data retention.

The demand for faster computer access to disk drives has generated new cache techniques to reduce seek time and rotational latency delays that account for about 60 percent of throughput bottlenecks. This technique is called the "turbo disk file cache" or "turbo" for short. The turbo eliminates disk seeks to frequently used data by transferring such data to a cache memory (typically 128K bytes) and accessing the data from the cache instead of the disk. The data in the cache is kept current using an algorithm such that the block of data that has gone unaccessed the longest is replaced by the next nearest-in-use block of data. The turbo algorithm considers past use and the probability for future use. Software 2000 Incorporated of Arroyo Grande, California, for example, sells TurboDOS, which it claims runs CP/M software three to five times faster. The company has adapted its software to run on most of the popular S-100 systems, the Xerox 820, TRS-80 Model II, and others.

Quote of the Month: "By the end of the century, analysts predict, computers and information processing will be the world's biggest business after petroleum." *Wall Street Journal,* November 10, 1981.

APOLOGY DUE: I regret that in my November 1981 column I erroneously reported that Canon was marketing the CX-1 computer via distributors responsible for software support. Canon has informed me that it markets the CX-1 directly to dealers and provides software support.

MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped enveope.

Sol Libes
POB 1192
Mountainside, NJ 07092

Clubs and Newsletters

Apple Group in Little Rock

The Little Rock Apple Addicts publish a newsletter and hold meetings and program swaps. Guest speakers have shown members how to diagnose ailing Apples and have demonstrated programs and peripherals. Contact Little Rock Apple Addicts, POB 55215, Little Rock, AR 72205.

Free Newsletter

The Softwaire Newsletter is a free bimonthly publication of the Softwaire Store in Los Angeles, California. It features news about personal and business CP/M software. Also included are reviews of microcomputer books, magazines, and games. Contact the Softwaire Store, 11768 West Pico Blvd., West Los Angeles, CA 90064, (213) 473-1136.

Llano Estacado Computer Club

Llano Estacado Computer Club would like to exchange ideas with other computer clubs. Members are interested in all microcomputers. Write to John L. Peters, Llano Estacado Computer Club, 1509 Fairway Terrace, Clovis, NM 88101.

Computer Association in Central Texas

The Central Texas Computer Association (CTCA) meets on the fourth Monday of the month at the Farm & Home Savings Building in Austin, Texas. Club meetings include short demonstrations or informal talks on a variety of subjects relating to personal computers. A monthly journal, *PRINT-OUT*, has information on hardware and software, new equipment critiques, and a classified ad section free to members. The CTCA is active in community service, with a number of projects underway for the deaf. Membership dues are $15. Contact CTCA, POB 17303, Austin, TX 78760.

HUGs in Pittsburgh

The Pittsburgh Heath Users Group (HUG) meets the third Tuesday of every month at the Heathkit store (3482 William Penn Hwy.) from 7 to 9 p.m. For more information, call (412) 824-3564.

Computer Dealers Society

The American Society of Computer Dealers (ASCD) is a new group devoted to promoting sound business practices in the used-computer industry. ASCD intends to cooperate fully with the Computer Dealers and Lessors Association in promoting ethical conduct standards. A code of ethics for ASCD members has been adopted. Meetings will be held twice a year, in February and July. For further details, contact ASCD, 3500 Southland Center, Dallas, TX 75201, or call Jerry Roberts at (313) 689-6200.

Magazine for War Gamers

The War Machine is a bimonthly magazine dedicated to fans of computer war games. It features news, reviews of complex games for all microcomputers, and advice for independent software writers. The latest issue can be obtained for $3 from Emjay, 17 Langbank Ave., Rise Park, Nottingham NG5 5BU, England.

Two New Groups in Munich

Two new microcomputer groups have been organized in Munich, West Germany. The European Branch of the Pascal Z Users Group has been formed in association with the American Pascal Z Users Group. And the second, the Ithaca Intersystems/S-100 Users Group plans to coordinate Ithaca users' efforts in Europe and to form a program exchange. Both groups can be contacted by writing George Brooke, Sebastian Bauerstrasse 20c, 8000 Munich 83, West Germany.

Dental Computer News

The *Dental Computer Newsletter* is a publication serving an international group of dentists, physicians, and office-management personnel who share a common interest in office computers. Members also have access to a software exchange and a computer bulletin board. Dues are $15 domestic, $23 overseas. Contact *Dental Computer Newsletter*, c/o E. J. Neiburger, 1000 North Ave., Waukegan, IL 60085. ■

Software Received

Apple

Adventure in Time, an adventure game for the Apple II. Floppy disk, $29.95. Phoenix Software Inc., 64 Lake Zurich Dr., Lake Zurich, IL 60047.

Birth of the Phoenix, a tutorial adventure for the Apple II. Floppy disk, $14.95. Phoenix Software Inc. (see address above).

Circuit Design System, a digital electronics design and simulation package for the Apple II. Floppy disk, $149. Smart Software Co., POB 1292, Orem, UT 84057.

Comma Usage/Semicolon and Colon Usage, a punctuation usage tutorial for the Apple II. Cassette, $20; floppy disk, $25. LARA Software, 980 Hunting Valley Pl., Decatur, GA 30033.

Context Connector, a Visicalc utility program for the Apple II. Floppy disk, $180. Context Management Systems Inc., 23864 Hawthorne Blvd., Torrance, CA 90505.

Datalink, a telecommunications package in Pascal for the Apple II. Floppy disk, $100. Link Systems, 1655 26th St., Santa Monica, CA 90404.

Linkdisk, a disk-utility package in Pascal for the Apple II. Floppy disk, $70. Link Systems (see address above).

Linkindex, a rapid key data-file retrieval system in Pascal for the Apple II. Floppy disk, $150. Link Systems (see address above).

Linksampler, a tutorial package in Pascal for the Apple II. Floppy disk, $60. Link Systems (see address above).

Linkvideo, a screen utility in Pascal for the Apple II. Floppy disk, $55. Link Systems (see address above).

Red Alert, an arcade-style game for the Apple II Plus. Floppy disk, $29.95. Brøderbund Software Inc., 2 Vista Wood Way, San Rafael, CA 94901.

Shadow Hawk One, an arcade-style game for the Apple II. Floppy disk, $49.95. Horizon Simulations, 107 East Main #2, Medford, OR 97501.

Zoom Grafix, a graphics/printer control package for the Apple II. Floppy disk, $39.95. Phoenix Software Inc. (see address above).

Atari

Easytext Word Processor, a word-processing system for the Atari 800. Floppy disk, $50. Dataworks Inc., 97 Jackson St., Cambridge, MA 02140.

The I Ching, a program for casting and displaying hexagrams for the Atari 800. Floppy disk, $44.95. Alternate Reality Software, 2111 West Arapahoe Dr., Littleton, CO 80120.

Shadow Hawk One, an arcade-style game for the Atari 400/800. Floppy disk, $49.95. Horizon Simulations, 107 East Main #2, Medford, OR 97501.

CP/M

Office System 80, a utility system for the CP/M operating system. 8-inch floppy disk, $195. The Information People, 443 Hudson Ave., Newark, OH 43055.

Quickscreen, a screen-formatting program for the CP/M operating system. 8-inch floppy disk, $149. Fox and Geller Associates Inc., POB 1053, Teaneck, NJ 07666.

The Formula, a multifunctioned, business-oriented data-processing package for CP/M. 8-inch floppy disk, $595. Dynamic Microprocessor Associates, 545 5th Ave., New York, NY 10017.

XLT86, an assembly-language conversion utility to convert CP/M programs to CP/M-86. 8-inch floppy disk, $150. Digital Research Inc., 801 Lighthouse Ave., POB 579, Pacific Grove, CA 93950.

TRS-80

LOG, a simple database management program for the TRS-80 Models I and III. Floppy disk, $44.95 (Model I), $49.95 (Model III). KSoft, 318 Lakeside Dr., Brandon, MS 39042.

Modem 80, a telecommunications software package for the TRS-80 Models I and III. Floppy disk, $39.95. The Alternate Source, 1806 Ada St., Lansing, MI 48910.

Smart Terminal, a telecommunications software package for the TRS-80 Models I and III. Cassette, $69.95. Howe Software, 14 Lexington Rd., New City, NY 10956.

Uniterm, a telecommunications software package for the TRS-80 Models I and III. Floppy disk, $29.95. BT Enterprises, 171 Hawkins Rd., Centereach, NY 11720.

Other Computers

Quadcube, an extended graphics simulation of the Rubik cube puzzle for the Texas Instruments TI-99/4. Cassette, $14.95. Linear Aesthetic Systems, POB 23, West Cornwall, CT 06796.

The ZX80 Business Package, a business-oriented program package for the ZX80 and MicroAce computers. Cassette, $9.95. Lamo-Lem Laboratories, POB 2382, La Jolla, CA 92038.■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

BYTE's Bugs

Closer Look Spies Bug

PC: The Independent Guide to the IBM Personal Computer is a bimonthly publication, not a monthly as stated on page 60 of Gregg Williams' article "A Closer Look at the IBM Personal Computer" (January 1982 BYTE). Subscriptions to the magazine cost $12 for six issues.

Please note that the new address for *PC: The Independent Guide to the IBM Personal Computer* is 1239 21st Ave., San Francisco, CA 94122, (415) 753-8088.■

Ask BYTE

Conducted by Steve Ciarcia

Speech Synthesizer Application

Dear Steve,

I read with great interest your article, "Build an Unlimited-Vocabulary Speech Synthesizer" (September 1981 BYTE, page 38), and have found a possible use for it. I have a Perkin-Elmer 3220 computer and would like to use the synthesizer to answer telephone calls into the computer, mainly to respond to salesmen who have phoned orders into the computer. The synthesizer would respond with appropriate messages, telling the salesmen if transmission was successful or what problem occurred. Could the synthesizer feasibly be used in this capacity on my computer, with or without modifications, and what modifications would be necessary, if any?

Derek Pitcher
Highland Park, NJ

The speech synthesizer requires only a Centronics-compatible parallel output port commonly used for printers. The port comprises 9 output lines and 2 input lines. If your computer has this capability, then the synthesizer can be easily interfaced as described in the article.

Your application is an excellent one. Many companies, including Ma Bell, use speech synthesizers on the telephone. Listen carefully the next time you dial a phone number that has been changed. . . . **Steve**

Problems with EPROM

Dear Steve,

I was very glad to see your article, "Build an Intelligent EPROM Programmer," in the October 1981 BYTE (see page 36). For the past several months, I have been trying to build a circuit to program EPROMs (erasable programmable read-only memory) using my homebrew 6809 computer and three output ports from 6820 Peripheral Interface Adapters. It was a bit of a surprise to see that my circuit is almost the same as yours. Mine does not work, however, and I can't figure out why.

I am using the 5-volt-only version of the 2716 EPROM, and my timing is done by a wait loop in software rather than by the one-shot TTL (transistor-transistor logic) device that you used. When I try to program a "known-good" 2716, it comes out with about one-fourth the bytes programmed (the rest are hexadecimal FF), and those bytes that are programmed are not necessarily right.

I checked all the address lines and data lines over and over again. I even single-stepped through the program, monitoring all the voltages as I went. Every pin is what it should be, but it just doesn't work right. I was wondering if you knew of any little idiosyncrasies of the 2716 that may cause such a symptom. Did you run into any such trouble with your circuit?

Matthew G. Cimbala
State College, PA

It sounds as if you have a software problem in which the addresses are not being placed on the EPROM in the right sequence. Perhaps your address-incrementing routine is resetting too soon.

The fact that you are getting data into the EPROM (assuming that all bytes were hexadecimal FF prior to programming) indicates that the program timing loop is okay. The 2716 is a very reliable EPROM and I am not aware of any idiosyncrasies that would cause this problem. I suggest you leave it alone for a few days and then walk through the software, paying close attention to your indexing instructions. . . . **Steve**

Modem Interface

Dear Steve,

I acquired an acoustically coupled modem made by Multi-tech Systems from New Brighton, Minnesota. This is the model FM 30; it has a full- or half-duplex switch on the bottom and also what appears to be an RS-232C input connector. I was wondering if you could provide any information on interfacing this with my Apple II Plus. Would one of the commercial interfaces work, such as the Apple Communications board or Mountain Computer's CPS Multifunction card? Any information would be greatly appreciated.

Steven M. Babick
Dolton, IL

Any board that provides an RS-232C serial input will be adequate to interface your modem to the Apple II Plus. The commercial interfaces that you mentioned are fine for this purpose.

For an explanation of how modems work, and some of the terminology associated with them, refer to my article, "A Build-It-Yourself Modem for Under $50," in the August 1980 BYTE, page 22. . . . **Steve**

High-speed Printers

Dear Steve,

I would like to build a 16-bit microcomputer system to drive a 600-line-per-minute printer. Printers like that are advertised in BYTE, but I have my doubts that anything can actually print at that speed. What do you think?

Colin Morris
New York, NY

Six-hundred-line-per-minute printers do indeed exist. Your doubts as to anything printing that fast are natural, especially if you are used to seeing a dot-matrix or daisy-wheel printer printing one character at a time. The higher-speed printers print a whole line at a time (like the old mechanical adding machines) and can be driven much faster.

I think the ultimate in printers is the IBM laser printer. It is capable of 1800 lines per minute. It works by having the laser, acting like the electron beam of a TV screen, scan a metal plate. The plate becomes charged, and the image is transferred to paper much like a xerographic photocopier. The problem with this type of printer is the manpower necessary to load and unload the boxes of paper that are used. . . . **Steve**

Level I Tape Format

Dear Steve,

I wrote a program that brought data from the tape and stored them in memory of my TRS-80 Model I so that I could examine them. But the data format did not match any listed in my refer-

ences. Part of the problem was that I was using a Level I BASIC machine and reading programs like Eliza, Micromovie, and Pyramid 2000.

So I modified my program to read Level II tapes and sure enough, the formats were correct. Can you tell me where to find the format for Level I tapes?

Bob Fabiano
El Cajon, CA

Radio Shack has machine-language programs for converting your Level I BASIC programs and data files into the Level II format. They are called CONV and DCONV, respectively, and are furnished free of charge when a Level I machine is upgraded to Level II. See your local Radio Shack dealer.

The Level I cassette-tape format can be found in The Custom TRS-80 and Other Mysteries *by Dennis Kitsz.* . . . **Steve**

Computer Lab Essentials

Dear Steve,

I am a sometime practitioner of simple chip and microprocessor designs. I am approaching retirement in a few years and I'd like to build more ambitious projects. To do that I'd like to set up a lab of sorts. Accordingly, I would value your recommendations about the kinds of test instruments I should be thinking about getting. I should tell you also that I have a 35-year-old degree in electrical engineering and, in the mid-fifties, I worked in hardware. The point being I'm not worried about my ability to use dual-trace scopes, voltmeters, and the like.

I'll probably try to build a computer from scratch. I was particularly intrigued by your article, "Build a Computer-Controlled Tank," in the February 1981 BYTE, page 44. Maybe I'll try to tie a specially built computer to a complex model railroad layout. I tell you this to give you an idea of what I think I'd like to do. I'm not especially worried about the price of the test instruments, but naturally I'd like to avoid buying the fanciest Tektronix scope. I'm an experienced kit builder, so if you think a particular Heath scope is a good value and desirable, that might be best.

B. H. Kramer
St. Louis, MO

The two instruments that are absolute musts for a computer lab are an oscilloscope and a DVM (digital voltmeter). The 'scope should have a 15 to 25 MHz bandwidth with dual trace and a time-base range between 200 nanoseconds and 0.5 seconds (without having to use the time-base magnifier). Vertical sensitivity should be at least 10 millivolts per division. Delayed sweep and trigger view are not necessary. I just purchased a Tektronix 2215 ($1400), and it is very good for the money. As for the DVM, any 3½ digit model should suffice.

Other useful equipment would be a function generator and variable-voltage power supply with short-circuit and overload protection.

The above recommendations should suffice for the application that you describe. In any event, this represents the foundation of a good lab system and will require only a modest investment. Enjoy your retirement. . . . **Steve**

Programming the RS-232C Serial Port

Dear Steve,

I have been unable to find any information on programming the RS-232C serial port on the Radio Shack Color Computer. A call to the "hot line" indicated that Radio Shack consultants were somewhat in the dark, although they tried to be helpful. Can you shed any light on this topic?

Martin F. Rooney
Troy, NY

The RS-232C serial port on Radio Shack's Color Computer consists of 3 bits of 3 addresses of a Motorola MC6821 Peripheral Interface Adapter (PIA). At address hexadecimal FF20, bit 1 represents the RS-232C Data Output and is brought out to pin 4 of connector P2. Address hexadecimal FF21, bit 1, is the Status Input line, connected to pin 1 of P2. Address hexadecimal FF22, bit 0, is the RS-232C Data Input and is connected to pin 2 of P2; pin 3 of P2 is ground.

In software, the only RS-232C device supported by the 8K-byte BASIC is a serial printer, so pin 1 of P2 is not used. Pin 2 is intended to be connected to the printer status or busy line, and pin 4 is the output to the printer. To program the MC6821, a rather elaborate discussion must ensue. An article from EDN *magazine, September 20, 1980, "Understanding PIA Operations Increases Your Design Options" by Randy Hutcheson, explains this rather well.*

The TRS-80 Color Computer Technical Reference Manual *(Cat. No. 26-3193) explains all the input/output ports and has a complete memory map. It is available through any Radio Shack store. . . .* **Steve**

Build Your Own

Dear Steve,

I have read some of your articles and especially liked "Build the Disk-80" (see the March 1981 BYTE, page 36), but I was sorry that it was not designed to work with 8-inch disk drives. I would like to build a computer, perhaps based on Zilog's Z80, with provisions for four 8-inch disk drives and with the ability to directly address 128K bytes of nonvolatile memory. Do you have any suggestions?

W. Edward Kelsey
New London, NH

I'm glad to see that there are still some people who enjoy building computers rather than buying them. Your idea of a Z80-based system sounds fine, but I don't plan anything like it in the near future. Below are a few suggestions that may help.

You don't say what your experience level is, but at the risk of sounding like a commercial I would recommend my book, Build Your Own Z80 Computer *(a McGraw-Hill publication available from BYTE Books, Peterborough, NH 03458). It contains the necessary information to build a complete computer and configure it any way that you wish.*

As for the disk controller and memory, I would suggest that you buy them either as bare boards or assembled and tested. Configure your Z80 to an S-100 bus and save yourself a lot of grief. You will have your fun building the Z80 and you will save a lot of headaches by using prewired boards for the rest of the system.

You then can use bank-selectable memory boards and can easily have your 128K bytes of memory. . . . **Steve**

Radio Frequency Interference

Dear Steve,

I have been reading your column in BYTE since I first picked up an issue about four months ago. I am writing this on my newly acquired Vector Graphic System B and would deeply appreciate a reply to a nagging question.

The Vector System B installed for word processing in my home is about 15 feet from our TV antenna (located on rafters in the garage—our elevation precludes an external antenna). The system kills channel 2 and distorts 5 and 7. The dealer suggested a Radio Shack filter, which did nothing. I learned from another dealer that the System B uses a crystal oscillator with a frequency near television channel 2.

Please suggest what course of action I should take or what remedies I might initiate myself, such as a radio-frequency filter a novice could install in or around the computer case.

Jacob D. Pottgen
New Lenox, IL

I'm glad to hear that you've been reading my column for the past four months. Had you read the January 1981 BYTE on page 48, you would have seen my article on "Electromagnetic Interference." After reading it, you should have enough information to solve your radio-frequency interference problems.

It is important to understand what causes the problem and to recognize that it is difficult to determine what may be radiating the interfering signal. . . . **Steve**

Plotting with the TRS-80

Dear Steve,

I would like to find a program that will allow me to make *x-y* plots of graphs of linear and logarithmic equations and data points. I have a TRS-80 Model III and an IDS-560 printer with graphics capability. I don't need to see the plots on the screen; I only need to be able to print them out on the IDS-560.

Any help you could give me would be most appreciated. Thanks a lot.

Donald M. Lammers
Wexford, PA

Programs for x-y plotting are available at your local Radio Shack store. The following two books are quite thorough in the explanation of equations and data points and are directed, naturally, toward Radio Shack BASIC: TRS-80 Programs, *Cat. No. 62-2064, and* TRS-80 Graphics, *Cat. No. 62-2063.* . . . **Steve**

A Matter of Environment

Dear Steve,

I've taken instructions from a page from your recent book, *Build Your Own Z80 Computer*, and modified them to "Build Your Own Z8000," which is the source of my problem. The S-100 system I'm designing uses a Zilog Z8001 segmented microprocessor with a 4 MHz 9511 arithmetic processor. Hardware design is a snap so far. (I plan to purchase the Disk-1 floppy-disk controller from Godbout and build all other boards that I need.) The problem will be software; specifically, I need an operating system such as Unix or Unix-compatible Coherent. But Coherent is written in unsegmented code.

Ask BYTE

Where can I get an operating system?

This sort of operating system is not the type usually advertised in BYTE; and you know how much good my beautiful hardware is going to be without it. (I'd prefer Unix if available.) The computer is intended as a multiuser, multitasking system, preferably with a FORTRAN compiler, as well as an assembler/editor/debugger.

Frank Barresi
Woodhaven, NY

Your problem is somewhat sticky. The problem is not altogether in the operating system. Unix, like CP/M, does not contain the primitives (software subroutines) for any I/O (input/output). Like CP/M's BIOS (basic input/output subsystem), these are totally hardware dependent.

In other words, you might be able to use Unix if you can write the subroutines for the I/O primitives. Be wary, however; Unix may use some strange hardware-dependent software, but I'm not an expert on Unix and can't be sure of this.

Two good sources of information about Unix are: The July-August 1978 issue of the Bell System Technical Journal, devoted to Unix, available for $2.98 from Bell Laboratories Circulation Group, Whippany Road, Whippany, NJ 07981; and Using the Unix System *by Richard Gauthier, Reston Publishing Co., Reston, VA, 1981.*

Get as much information on Unix as you can and study the various implementations of Unix. Pay special attention to system environmental requirements and I/O requirements.

What it all boils down to is this: if you can make your hardware as much like the proper environment for Unix as possible, it should work. (By the way, I'll let you know when I do anything with the Z8000. Remember what happened to Colossus in the sequel?) Good luck in any event. . . . **Steve**

Feasibility Study

Dear Steve,

I am presently studying electronics at a technical school. I have a technical writing course in which we are assigned to do some sort of feasibility study. I have chosen to do mine on the feasibility of purchasing a microcomputer for home use.

I am hoping that you could give me some references and, if possible, pass along some information which would help me in my study. This would be most appreciated.

Douglas E. Sprague
Hancock, ME

There is a wealth of information available on purchasing a computer for home use. The field of home computing is rapidly expanding and makes an excellent choice for a feasibility study.

The following are some references that should be quite helpful: Popular Computing, *November 1981;* Personal Computing—Home Professional and Small Business Applications *by Daniel R. McGlynn, John Wiley and Sons, 1979; and* Your Own Computer *by Mitchell Waite and Michael Pardee, Howard W. Sams & Co. . . .* **Steve**

VIP Expansion

Dear Steve,

I have an RCA COSMAC VIP with the 20K-byte memory upgrade so that I can use the VIP Floating Point (VIP 711). What I would like is to add a printer. Is it possible to do this with the VIP 711? I

know very little about the 1802 microprocessor.

I also have a TRS-80 with 48K bytes of memory, one disk drive, and a printer, and I have a Quick Printer 2. I would like to hook up the Quick Printer 2 to the VIP, but I don't even know how to start. I have no knowledge of electronics at all. Is this project possible? If so, where would I get the driver for the printer? (I have looked for 1802-based software to drive a printer, but so far, no soap.) Can you help me?

Nicholas Mulchin
Meadville, PA

The RCA COSMAC VIP is a powerful single-board computer. Unfortunately, there is little support for it in the computer magazines. It does, however, have expansion capability in the form of a 44-line I/O (input/output) interface that will allow almost anything to be added, including up to 32K bytes of programmable memory. It requires a fair amount of technical skill to accomplish the interface.

I doubt if there exists a printer interface such as you are looking for that would simply "plug in" to your VIP. The two manufacturers listed below make interface boards for the 1802 processor, and they may have the necessary information to connect with the VIP: Netronics Research & Development, Ltd., 333 Litchfield Road, New Milford, CT 06776, (203) 354-9375; and RCA Solid State, Box 3200, Somerville, NJ 08876.

Any software must first test the "printer busy" signal. If it is active, the computer must not send data to the printer, or it will not be seen. When the busy signal is low, the 8-bit data character may be sent from the output port which will cause the printer to print it. When the next character is ready, the process must begin again. . . . Steve

TTL Data Books

Dear Steve,

I am looking for a TTL (transistor-transistor logic) data book that has descriptions and pinouts for the majority of the manufactured ICs (including the special and less frequently used ICs). Your suggestions are appreciated.

Paul Russo
Naples, FL

Every manufacturer of integrated circuits publishes a data book for its product line. One of the most readily available data books is published by National Semiconductor and is available at your local Radio Shack store or through Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002, (415) 592-8097. Price lists for various data books can also be obtained by writing directly to the manufacturers. . . . Steve ■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033
If you are a subscriber to The Source, send your questions by electronic mail or chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

Event Queue

March 1982

March

Courses and Seminars from George Washington University, Amsterdam, Netherlands; London, England; Long Island, NY; San Diego, CA; and Washington, DC. Among the courses and seminars to be presented are "Microcomputers in Control Systems," "Comparative Database Management Systems," and "Structured Programming and Software Engineering." For further information, contact The Director, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in Washington, DC, (202) 676-6106.

March

Courses in Structured Systems, various sites throughout the U.S. Courses in "Structured Systems Design" and "Structured Requirements Definition" are being offered by Ken Orr and Associates. For information on meeting times, places, and fees, contact Ken Orr and Associates Inc., 715 East 8th, Topeka, KS 66607, (800) 255-2459; in Kansas (913) 233-2349.

March-April

Computer Network Design and Protocols, various sites throughout the U.S. Participants in this workshop will learn to determine network-system requirements and to perform design trade-offs, implement network-communication and control protocols, use packet- and message-switching techniques, evaluate network hardware and software components, interface local systems to networks, and design and build private networks. The course fee is $845. Contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

March-April

Fundamentals of Data Processing for Administrative Assistants and Office Support Staff, various sites throughout the U.S. The American Management Associations (AMA) has designed this three-day course for secretaries, assistants, supervisors, and other personnel desiring to learn the fundamentals of data processing and its use in offices. Computer hardware, software, programming languages, and technology will all be covered. The team fee for AMA members is $470 per individual and $550 for nonmembers. Individual fees are $550 for AMA members and $630 for nonmembers. For a schedule of dates and locations, contact the AMA, 135 West 50th St., New York, NY 10020, (212) 586-8100. To register by phone, call (212) 246-0800.

March-May

Courses from Boeing Computer Services, various sites throughout the U.S. Boeing Computer Services is offering a wide variety of computer-related courses at its regional service centers. Course topics range from "Introduction to Data Processing" to "Structured Program Development in FORTRAN." For a complete schedule of times, locations, and fees, contact Boeing Computer Services Co., Education and Training Div., POB 24346, Seattle, WA 98124, (206) 575-7700.

March-May

Seminars and Conferences from Datapro Research, various sites throughout the U.S. Among the topics to be presented are "IBM's Systems Network Architecture," "Data Dictionary/Directory Systems," and "Data Processing: Fundamental Concepts." Enrollment fees are $640 for Datapro subscribers and $690 for nonsubscribers. For a complete catalog with descriptions, dates, and locations, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

March-June

Datamation Institute Seminars on Information Management, various sites throughout the U.S. Databases and communications, systems performance, data-processing management, word processing, office automation, computer graphics, and topics of general interest are among the areas to be covered by these two-day seminars. Fees range from $495 to $595. For schedules of times and places, contact Karen Smolens, c/o the Center for Management Research, Datamation Institute Seminar Coordination Office, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

March-June

National Computer Graphics Association Seminar, various sites throughout the U.S. The National Computer Graphics Association's (NCGA) Winter/Spring 1982 Seminar program covers such topics as "Computer Graphics: Technology and Applications," "Successful Business Graphics," and "Applications of Computer Graphics to Transportation Problems." Seminar fees are $395 for association members and $425 for nonmembers. For complete details, contact Eloise Wenker, NCGA Seminar, 2033 M St. NW, #300, Washington, DC 20036, (202) 466-4102.

March-June

Intensive Two-day Seminars for Professional Development, various sites throughout New England. Among the seminars to be offered by Worcester Polytechnic Institute are "Fundamentals of Data Processing," "Distributed Systems: The Architecture and Utilization of this Revolutionary Technology," and "Microprocessors: Hardware, Software, and Applications." Registration fees range from $445 for a two-day program to $990 for a 7-day executive institute. For complete details, contact Ms. Ginny Bazarian, Office of Continuing Education, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

March-June

One- and Two-day Professional Development Seminars, various sites in the greater Boston area. Among the courses being offered by Boston University are "Business Writing for Results," "Improving Customer Service," and "Assertive Management." Registration fees range from $295 for a one-day program to $445 for a two-day program. These seminars can be conducted within your company. For details, contact Ms. Joan Merrick, Center for Management Research, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020. For information on the in-company seminars, contact Ms. Elaine Dee at the same address.

March-June

Courses and Seminars from Sira Institute, various sites throughout England. Sira Institute is sponsoring seminars on a wide variety of subjects ranging from microprocessor familiarization to design and development of microprocessor-based equipment. For details, contact Conferences & Courses Unit, Sira Institute Ltd., South Hill, Chislehurst, Kent BR7 5EH, England.

March-July

Technical Classes from Zilog, Campbell, CA. Zilog is offering a series of one- to five-day technical classes at its California-based training facility. Topics range from "Microprocessors: A General Introduction" to "Zeus/System 8000 User." Contact Zilog, Training Dept., 1315 Dell Ave., Campbell, CA 95008, (408) 446-4666.

March 9-11

The 1982 International Zurich Seminar on Digital Communications, Zurich, Switzerland. The theme of this seminar is "Man-Machine Interaction." Its aim is to present recent advances in theory and application of digital-communication systems. Services, facilities, ergonomics, and their impact on peripheral equipment, systems architecture and design, as well as I/O (input/output) concepts and principles will be covered. For details, contact Secretariat '82 IZS, Ms. M. Frey, EAE, Siemens-Albis AG, POB CH-8047, Zurich, Switzerland.

March 9-11

Understanding and Using Computer Graphics, Dallas Hilton Inn, Dallas, TX. This seminar is designed for those needing information about interactive computer graphics, including hardware, software, and applications. Headed by Carl Machover, the seminar provides a comprehensive overview of the state of the art in graphics systems. For details, contact Bob Sanzo, c/o Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080.

March 9-12

Digital Image Processing and Analysis, San Diego, CA. Integrated Computer Systems' course in digital-image processing is designed for engineers, scientists, technical managers, and other professionals responsible for the specification, design, implementation, or application of digital-image processing systems. Among the topics to be covered are image acquisition, image-processing software and database structures, interactive two- and three-dimensional image processing and display, and real-time arrays. Some of the applications examples to be presented are quality assurance and robot vision. The course fee is $795; on-site courses can be arranged. Contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

March 9-12

VIO-Voice Input/Output for Computers, Los Angeles, CA. This four-day course is designed for product development and design engineers, systems analysts, programmers, and technical managers involved in the planning, design, and implementation of voice input/output systems. The topics to be covered include voice-processing algorithms and software, evaluating VIO hardware components and systems, utilizing speech-synthesis techniques, and designing voice-recognition techniques. Participants will have the opportunity to work with devices that permit online generation of computer-voice output, data entry by means of voice input, and voice input for system control. The course fee is $795; on-site courses can be arranged. For information, contact Ruth Dordick, c/o Integrated Computer Systems, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California (800) 352-8251.

March 10-12

Cincinnati Business Show, Cincinnati Convention Center, Cincinnati, OH. The Cincinnati Business show features the latest in business technology, office systems, and products. Seminars will also be presented. For information, contact Ray G. Nemo, 5679 Creek Rd., Cincinnati, OH 45242, (513) 531-5959.

March 12-13

The Fifth Annual Computers in Education Conference, Seattle Pacific University, Seattle, WA. Sponsored by Seattle Pacific University and the National Council for Computers in Education, this conference features concurrent talks, workshops, and discussions. Special emphasis will be placed on curricular uses of microcomputers in kindergarten through 12th grade. Contact Tony Jongejan, Everett High School, Everett, WA 98201.

March 12-14

FantasyLair '82, Ponca City, OK. The Northern Oklahoma Dungeoneers will be sponsoring tournaments and games in role-playing, war simulation, and many other card and board games. Admission is $10 per day. Contact Shelby Cooper, c/o Northern Oklahoma Dungeoneers, POB 241, Ponca City, OK 74602, (405) 762-6077.

March 15-17

Microprocessor Background for Management Personnel, Albuquerque, NM. This course is sponsored by the Electrical and Computer Engineering Department of the University of New Mexico. The course fee is $375. For details, contact Dr. Martin Bradshaw, Engineering Continuing Education, University of New Mexico, Albuquerque, NM 87131, (505) 277-4354.

March 15-19

Short Course from UCLA, Boelter Hall, University of California-Los Angeles (UCLA), Los Angeles, CA. "Mechanical Reliability, Design by Reliability, Probabilistic Design—The Stress/Strength Interference Approach to Reliability Prediction" is a short course being presented by UCLA. The course fee is $795, which includes comprehensive course notes. For details, contact Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Dept., University of Arizona, Tucson, AZ 85721, (602) 626-2495 or (602) 626-3901. In California, call Robert Rector at UCLA, (213) 825-1295 or (213) 825-3334.

March 16-18

Software/expo-West, Anaheim Convention Center, Anaheim, CA. This conference and show is devoted to packaged software. Exhibitors will display a wide range of software products. For additional information, contact Software/expo-West, Suite 400, 222 West Adams St., Chicago, IL 60606, (312) 263-3131.

March 16-19

Digital Filters and Spectral Analysis, Boston, MA. Integrated Computer Systems (ICS) is presenting this four-day course for project and design engineers, programmers, and technical managers responsible for implementing

Event Queue

advanced digital signal-processing systems and for others who must understand them and their potential. Fundamentals of digital signal processing, fast Fourier transform (FFT) algorithms, and special- and general-purpose LSI/VLSI (large-scale and very large-scale integration) devices are among the topics to be addressed. The course fee is $795; on-site courses can be arranged. Contact Ruth Dordick, c/o ICS, 3304 Pico Blvd., POB 5339, Santa Monica, CA 90405, (800) 421-8166; in California, (800) 352-8251.

March 17

Evaluating Decision Support Software: A Managerial Perspective, Suffolk University School of Management, Boston, MA. This conference is sponsored by the local chapters of six management and computer associations. It will examine the managerial issues involved in choosing decision-support software. The focus will be on end-user characterization, problem diagnosis, needs assessment, and the implications of the evaluation and selection process. Industry experts will speak. Contact DSS Conference, 215 First St., Cambridge, MA 02142, (617) 547-5061.

March 19

The Eleventh Annual International Computer Programs Awards Ceremony and Executives' Conference, Savoy Hotel, London, England. The annual International Computer Programs (ICP) awards ceremony honors super software salespeople, advertising agencies, public relations firms, and achievements in the industry. The executive conference is one and a half days of discussion of the major issues and concerns of the industry. The fee for the executive conference is $250. For information, contact Carol Stumpf, c/o ICP, 9000 Keystone Crossing, POB 40946, Indianapolis, IN 46240, (800) 428-6179; in Indiana, (317) 844-7461. In England, contact International Computer Programs Inc., 2 Deanery St., Park Lane, London WIY 5LH, England, Tel: 01 499 6621.

March 19-21

The Seventh West Coast Computer Faire, Civic Auditorium and Brooks Hall, San Francisco, CA. Attendance this year is expected to reach 35,000. More than 300 exhibitors and a wide assortment of seminars make this one of this largest annual computer shows. For more information, contact The Computer Faire, 333 Swett Rd., Woodside, CA 94062, (415) 851-7075.

March 22-23

Oasis Level Two Training Seminars, Phase One Systems, Oakland, CA. Using a step-by-step approach to developing applications software with the multiuser Oasis operating system, this seminar begins with program design and proceeds to a careful study of the Oasis system. Topics to be covered are the Oasis BASIC interpreter and compiler, program segments, file structures and I/O (input/output), matrices and matrix I/O, multiline branching structures, and subroutine and error handling.

The registration fee for this three-day session is $350. Some background in BASIC programming is recommended. Contact Phase One Systems, Suite 830, 7700 Edgewater Dr., Oakland, CA 94621, (415) 562-8085.

March 22-25

Interface '82 Conference and Expo, Dallas Convention Center, Dallas, TX. Cosponsored by McGraw-Hill's *Business Week* and *Data Communications* magazines, Inter-

face '82 is aimed at users of data-communication equipment, distributed-data processing, and various networks. For details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 22-26

Computers/Graphics in the Building Process, Washington, DC. This international conference is sponsored by the Advisory Board on the Built Environment (ABBE) of the National Academy of Sciences and by the World Computer Graphics Association (WCGA). The conference features tutorials, technical paper sessions, and exhibits that reflect the state of the art of computers and computer-graphics technology in the building industry. Sessions on case studies, current achievements, and research and development of computer hardware, software, and database programs will be presented. Conference topics include computer aids to management, computer technology, and computer-aided analysis in design development and construction documents. For further details, contact the WCGA, Suite 250, 2033 M St. NW, Washington, DC 20036, (202) 775-9556.

March 22-26

Tutorial Week East '82, Orlando Marriott Inn, Orlando, FL. Tutorial Week East is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) and will consist of 15 tutorials arranged in three tracks: VLSI (very large-scale integration) microprocessor interfacing techniques and graphics; aspects of software design, analysis, and techniques; and data communications, computer networking, and databases. Fees are $90 per tutorial, $400 all week, for IEEE members, and $110 per tutorial, $500 all week, for nonmembers. For information, contact Tutorial Week East '82, POB 639, Silver Spring, MD 20901, (301) 589-3386.

March 23-25

Southcon '82, Sheraton Twin Towers Hotel, Orlando Hyatt Hotel, and Holiday Inn International Drive, Orlando, FL. Among the topics to be presented at Southcon '82 will be artificial intelligence and robotics, office automation, computers and microprocessors, and software. For complete details, contact Robert Myers, c/o Electronic Conventions Inc., Suite 410, 999 North Sepulveda Blvd., El Segundo, CA 90245, (213) 772-2965.

March 26-28

The 1982 Computer Showcase Expo, Atlanta, GA. The Computer Showcase is designed for small-business owners, independent professionals, and corporate managers. Admission is $7.50. For further details, contact The Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

March 27-28

Amateur Radio and Computer Hobbyists (ARCH) Convention, Chase Park-Plaza Hotel, St. Louis, MO. This convention features exhibitions, workshops, forums, and a flea market. For details, contact Gateway Amateur Radio Association, POB 8432, St. Louis, MO 63132, (314) 361-4965.

March 29-30

Information Utilities '82, Rye Town Hilton Hotel and Conference Center, Rye, NY. The Information Utilities conference will focus on videotex, transactional services, electronic publishing, online database services, cable advertising, and regulations concerning copyright, censorship, and communications. More than 60 speakers are scheduled. For details, contact Online Inc., 11 Tannery Ln., Weston, CT 06883, (203) 227-8466.

March 29-April 1

INFOCOM '82, Las Vegas, NV. INFOCOM '82 is sponsored by the Institute of Electrical and Electronics Engineers (IEEE) Computer and Communications Societies. The conference theme is "Data Processing—Data Communications: The Illusory Boundary." Focusing on the convergence of computer and communication technology, this conference will attempt to bridge the boundary between the two disciplines. Discussions on programming-language and operating system design, performance evaluation and analysis of computer-communication networks and protocols, standards, and the design of distributed computing and database management systems will be held. Exhibits and tutorials are planned. Write to INFOCOM '82, POB 639, Silver Spring, MD 20901, (301) 589-3386.

March 30-April 2

Digital Image Processing and Analysis, Washington, DC. For details, see March 9-12.

April 1982

April

Courses from George Washington University, Hampton, VA; Salem, NH; Washington, DC; London, England; and Berlin, West Germany.

Among the courses scheduled are "Voice Input/Output," "Microwave Systems Planning," "Writing Professional and Technical Communications," and "Computer Graphics Systems: Design and Applications." For further information, contact Continuing Engineering Education, School of Engineering and Applied Science, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

April

Courses in Structured Systems, various sites throughout the U.S. "Structured Systems Design," "Structured Requirements Definition," and "Management Overview of Data Structured Systems Development" are being offered by Ken Orr and Associates. For information on meeting times, places, and fees, contact Ken Orr and Associates Inc., 715 East 8th, Topeka, KS 66607, (800) 255-2459; in Kansas, (913) 233-2349.

April

Knowledge Engineering in the 1980s, Boston, MA. Expert Systems are computer programs that reason in tasks that require considerable human expertise, such as locating computer malfunctions, monitoring intensive-care patients, analyzing noisy signal data, and diagnosing medical problems. This one-day executive briefing provides an introduction to the potential benefits and costs of Expert Systems. For further information, contact Dina Barr, c/o Teknowledge, 151 University Ave., Palo Alto, CA 94301, (415) 326-6827.

April 1-2

The Eleventh Annual International Computer Programs Awards Ceremony and Executive Conference, Marriott Mountain Shadows Resort, Scottsdale, AZ. The annual awards ceremony honors super software salespeople, advertising agencies, public relations firms, and microcomputer software achievements. The executive conference discusses the main issues and concerns of the industry, such as productivity through proper use of people and machines, new software-piracy solutions, and how to get the most out of advertising dollars. The fee for the executive conference is $250. For detailed information, contact Carol Stumpf, c/o ICP, 9000 Keystone Crossing, POB 40946, Indianapolis, IN 46240, (800) 428-6179; in Indiana, (317) 844-7461.

April 2-3

Educational Computing—The Future Is Now, Anchorage, AK. The Educational Computing Conference is sponsored by the Alaska Association for Computers in Education. Invited speakers, exhibits, and demonstrations of microcomputer products for educational purposes will be featured. Admission to the exhibition area is free of charge. For further details, contact Pat Stowers, '82 Educational Computing, Drawer 129, Healy, AK 99743, (907) 683-2278.

April 2-4

The Second Annual Eighty/Apple Computer Show, New York Statler Hotel, New York, NY. The Eighty/Apple Computer Show features products and services for TRS-80 and Apple computer systems. More than 100 exhibitors of hardware, software, books, magazines, supplies, services, and accessories will attend. For more information, contact Kengore Corp., 3001 Rte. 27, Franklin Park, NJ 08823, (201) 297-2526.

April 4-7

The Seventh Annual Deltak International Training Conference, Access 82, Hyatt Regency, Chicago, IL. More than 1000 training and electronic data-processing professionals are expected to attend 35 workshop sessions. Former president Gerald R. Ford will deliver the keynote address. The registration fee is $525. Information is available from Gail Bohan, c/o Deltak Inc., 1220 Kensington Rd., Oak Brook, IL 60521, (312) 920-0700.

April 5-7

The Third Annual Office Automation Conference, George R. Moscone Convention Center, San Francisco, CA. This conference is sponsored by AFIPS (American Federation of Information Processing Societies). Exhibits and workshops will be featured. For details, contact Betty Lou Cooke, c/o AFIPS, 1815 North Lynn St., Arlington, VA 22209, (703) 558-3612.

April 6-8

The Sixth Annual Computerized Office Management Expo-Midwest '82, O'Hare Expo Center, Chicago, IL. This conference and exhibition features business-oriented equipment for word and data processing, information management, record storage and retrieval, and micrographics. A three-day high-technology symposium, "Business Automation and Communications" will highlight Midwest '82. For details, contact Cahners Exposition Group, 222 West Adams St., Chicago, IL 60606, (312) 263-4866.

April 13-16

Digital Image Processing and Analysis, Boston, MA. For details, see March 9-12.

April 14-18

Electronic Home Entertainment Show, Arlington Park Race Track Exposition Hall, Arlington Heights, IL. This show will feature audio and video equipment, video games, home computers, and citizen-band radio systems. It will run concurrently with the Fourth Annual Energy & Home Improvement Faire. Contact Expo Management Inc., Suite S2-132 Arcade, The Apparel Center, Chicago, IL 60654, (312) 329-1191.

April 15-17

The 1982 Computer Showcase Expo, St. Louis, MO. For details, see March 26-28.

April 15-18

The Second Southwest Computer Show and Office Equipment Exposition, Market Hall, Dallas Market Center, Dallas, TX. This features mini- and microcomputers for business, education, government, industry, home, and personal use. Data- and word-processing equipment, office machines, computer peripherals, and office supplies will be displayed. General admission is $5. Contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

April 16-17

The Twelfth Annual Virginia Computer Users Conference, Marriott Hotel, Blacksburg, VA. This conference is sponsored in cooperation with the ACM (Asssociation for Computing Machinery). Topics of interest are artificial intelligence, office automation, and database management. Contact Deidre Maskaleris or Wesley Braudaway, 562 McBryde Hall, Virginia Polytechnic Institute & State University, Blacksburg, VA 24061, (703) 961-6931.

April 19-21

Open Systems Interconnec-

tion with X.25 and Other Related Protocols, Denver Marriott Hotel-City Center, Denver, CO. Sponsored by *DataCommunications*, a McGraw-Hill publication, this seminar will present a thorough treatment of the basic OSI (Ohio Scientific) Reference Model, describing the seven-layer structure, service definitions, and emerging protocols. Detailed presentations of the X.25 packet protocol will be included. The seminar fee is $690. For further details, contact the McGraw-Hill Conference & Exposition Center, Rm. 3677, 1221 Avenue of the Americas, New York, NY 10020, (212) 997-4930.

April 20-22

D-COM, Hynes Auditorium, Boston, MA. D-COM will bring DEC (Digital Equipment Corporation) vendors together with DEC users. For information, contact Ron Davies, D-COM Inc., 7312 Burdette Court, Bethesda, MD 20817, (301) 469-7650.

April 20-23

VIO—Voice Input/Output for Computers, Boston, MA. For details, see March 9-12.

April 21-28

Hanover Fair '82, Hanover, West Germany. The annual Hanover Fair is one of the world's largest industrial and trade exhibitions. More than 330 American firms are expected to exhibit products, services, and technology at the Fair. Contact M.A. Delia, Hanover Fairs Information Center, POB 338, Whitehouse, NJ 08888, (800) 526-5978; in New Jersey, (201) 534-9044.

April 22

California Computer Show, Hyatt Hotel, Palo Alto, CA. This show is for OEMs (original equipment manufacturers), knowledgeable users, distributors, and dealers. More than 60 computer manufacturers will be exhibiting mainframes, mini- and microcomputers, and peripherals. Contact Carol Reimer, c/o Norm De Nardi Enterprises, 289 South San Antonio Rd. #204, Los Altos, CA 94022, (415) 941-8440.

April 22-25

New York Computer Show and Office Equipment Exposition, Nassau Coliseum, Uniondale, NY. For details, see April 15-18.

April 23-25

The 1982 Computer Showcase Expo, Miami, FL. For details, see March 26-28.

April 24

Computer Swap America, Santa Clara County Fair Grounds, San Jose, CA. This high-technology flea market features everything from home satellite-receiving stations to floppy disks. Admission is $3. Contact Computer Swap America, POB 52, Palo Alto, CA 94302, (415) 494-6862.

April 27-28

The Eighth Annual National Computer Security and Privacy Symposium: Top Secret '82, Washington, DC. Sponsored by Honeywell, approximately 22 national authorities on computer security and

privacy will speak on a variety of topics. Training workshops in security planning and risk analysis, disaster recovery and contingency planning, and computer fraud investigation will be held. The fee for the symposium is $525; discounts on multiple registrations are available. Contact the Security Symposium Registrar, Honeywell Inc., M/S T-99-4, POB 6000, Phoenix, AZ 85005; or call Jerome Lobel, (602) 249-5370.

May 1982

May-June
Sensors & Systems '82, various sites throughout the central and western regions of the U.S. This series of three-day conferences will cover all aspects of sensor technology from temperature sensors through to displacement, velocity, acceleration, magnetic field, and moisture. Other topics to be covered include signal conditioning, digital interfaces, and system interfaces. Contact Network Exhibitions, 785 Harriet Ave., Campbell, CA 95008, (408) 370-1661.

May 6-9
The Southern California Computer Show & Office Equipment Exposition, Los Angeles Convention Center, Los Angeles, CA. This show features mini- and microcomputers for business, education, government, industry, home, and personal use. Word- and data-processing equipment, office machines, and computer peripherals will be displayed. Admission is $5. For details, contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

May 7-9
The 1982 Computer Showcase Expo, Anaheim, CA. For details, see March 26-28.

May 10-12
Dexpo 82, Marriott Hotel, Atlanta, GA. This exposition features DEC- (Digital Equipment Corporation) compatible hardware, software, and services. Contact Expoconsul International Inc., 19 Yeger Rd., Cranbury, NJ 08512, (609) 799-1661.

May 10-14
The Twentieth Annual Convention of the Association for Educational Data Systems (AEDS), Sheraton Twin Towers, Orlando, FL. This convention includes presentations on the state of the art in educational computing. Administrative and instructional computing applications will presented, and new ways of improving educational processes will be explored. Contact Shirley Easterwood, c/o AEDS, 1201 Sixteenth St. NW, Washington, DC 20036.

May 14-15
The Second Annual Southern California Computers-in-Education Conference, University High Scool, Irvine, CA. This conference covers the application of computers in education from kindergarten through two-year college. All areas of curriculum will be touched upon, including reading, mathematics, science, language, and special education. Hands-on workshops and field trips are planned. Contact Craig Walker, Arrowview Intermediate School, 2299 North G St., San Bernardino, CA 92405, (714) 886-9118.

May 14-16
Applefest/Boston, Hynes Auditorium, Boston, MA. This show will feature more than 200 displays and booths of Apple-compatible products and accessories. Seminars and panel discussions will be held. Ticket prices are $6 per day or $15 for a three-day pass. Contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, (617) 739-2000.

May 15-16
The North American Computer Othello Championship, Learning Resources Center, Andersen Hall, Northwestern University, Evanston, IL. This two-day tournament is sponsored by the United States Othello Association. Champions will be determined in three categories: microcomputer systems (located on site), mainframe systems (telephone hookup), and special-purpose Othello machines. For complete tournament details, write to Professor Peter W. Frey, Dept. of Psychology, Northwestern University, Evanston, IL 60201.

May 18-20
Microcomputers—A New Tool for Foresters, Purdue University, West Lafayette, IN. Sponsored by Purdue University's Department of Forestry and Natural Resources and by the Inventory and Systems Analysis Working Groups of the Society of American Foresters, this conference seeks to advance the professional forester's knowledge of microcomputers and to introduce currently available microcomputer applications in forestry. Session themes include hardware and software considerations as well as information-processing and forest-inventory systems. Contact John W. Moser Jr., Dept. of Forestry and Natural Resources, Purdue University, West Lafayette, IN 47907, (317) 494-3596.

May 19-21
Computer Hong Kong 82, Regent Hotel, Hong Kong. This three-day program, which embraces the Fifth Hong Kong Computer Conference, will focus on the electronic data-processing market. For further details, contact Kallman Associates, 5 Maple Court, Ridgewood, NJ 07450, (201) 652-7070.

May 21-23
The 1982 Computer Showcase Expo, Boston, MA. For details, see March 26-28.■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least four months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock, NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

BYTE's Bits

Computer Camps

The 1982 National Computer Camp for boys and girls ages 10 to 18 will be held July 11 to August 6 in Simsbury, Connecticut, and Atlanta, Georgia. The kids will learn on mini- and microcomputers in small groups with ample hands-on time. The camp director, Professor Michael Zabinski of Fairfield University, is assisted by elementary and secondary school teachers. For more information, contact Michael Zabinski, POB 624, Orange, CT 06477, (203) 795-3049.■

The Computer Toolbox

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Harvard University
12 Oxford St.
Cambridge, MA 02138

Scientists everywhere are learning to detest small computers. They hate the things with a special passion reserved for anything that interferes with their research. Although researchers were among the first to embrace the promise of small, inexpensive computers, many now avoid using microcomputers in their labs.

It oughtn't to be so. Scientists *need* computers to monitor, coordinate, and control their experiments. Communicating rapidly and reliably with many different instruments, a computer can read and record data while responding swiftly to any problems that develop. The computer cannot grow bored or tired, nor will it object to uncomfortable or dangerous working conditions.

Above all, experimenters need the flexibility and adaptability that computers promise. Labs are exciting, disorganized, chaotic places. Cables run everywhere to connect instruments piled on tables and stacked on the floor. New equipment and new procedures are commonplace; ideas and plans are in continual flux. Even when everything works perfectly, the results of a few hours' work may call for a complete redesign of the entire experiment.

The modern microcomputer is easy and inexpensive to reprogram, so it *ought* to be a superbly flexible lab assistant. But it is this promise that small computers have betrayed. Microcomputers, expected to help scientists manage the constantly changing laboratory environment, implacably oppose every change and trivial modification.

Each change in the experiment calls for new software. Each new instrument needs new software. Every modification of hardware or technique demands new software. The computer's constant hunger for new and revised programs may be so daunting that promising experiments aren't even attempted. Laboratory computers have to be intimately involved with many aspects of the experiment, but this intimacy demands that they change and adapt constantly. Unfortunately, common programming techniques often produce programs that are obscure to read and tedious to modify.

The Computer Toolbox

Rather than design an inflexible computer for a specific job, our research group has tried to build a general-purpose laboratory assistant that can be carried, like a toolbox, from one experiment to another. *It is* an integrated, consistent package of hardware and software tools for the experimenter, who should be able to patch together a working system in a few days.

Just as a regular toolbox includes many wrenches and screwdrivers of various sizes, the computer toolbox contains many different "inlets" and "outlets" for information and a collection of interfaces of various sorts. Few experiments use every part in the toolbox; we tried to provide enough interfaces of each type for any experiment we expect to do.

The toolbox includes not only many types of interfaces but also

Device Type	Useful For	Relative Cost	Suggested Quantity and Comments
parallel input port	reading digital devices	inexpensive	many
parallel output port	controlling digital devices on/off controls	inexpensive	many
keyboard	input from people	moderate	1
video display	output to people	expensive	use extra displays for graphics
serial interface	interface printers, computers	moderate	1-5
printer	permanent records	expensive	1
plotter	permanent records	expensive	1
telephone interface	report emergencies	moderate	1 if experiment must run unattended
analog-to-digital converter	analog input	inexpensive	some
digital-to-analog converter	analog output	moderate	some
sound generator	alarms and warnings	inexpensive	many distinct noises can be invaluable
digitizing tablet	input from charts and graphs	expensive	if required
joystick	input from people	inexpensive	sometimes convenient
stepping motor	moving things	inexpensive	very useful
AC controller	power control	moderate	several
arithmetic processor	arithmetic	expensive	for demanding calculations

Table 1: *Widely useful equipment for computer toolboxes.*

many interfaces of each different type (see table 1). Redundant facilities add little to the cost or complexity of the toolbox and greatly enhance its usefulness. Because several interfaces of each type are available, adding new apparatus to an experiment is easy. Scientists will not be forced to choose between one instrument and another, because they are free to connect lots of instruments at once.

If an interface circuit is accidentally damaged, redundant interfaces allow work to continue. The computer need not be repaired immediately, and the damaged interface can be fixed at the scientist's convenience. Redundancy makes the system robust, despite the hazards of the laboratory environment.

Software Design in the Lab

Most laboratory programs live only a few weeks or months. Indeed, many programs are modified so often that they are really never "finished." To make matters worse, laboratory software is written by scientists, i.e., by ingenious, amateur, and relatively unschooled programmers. The lab computer must emphatically encourage clean, comprehensible, modifiable programming.

Lab programmers face a diverse and confusing array of complicated devices, each posing distinct programming problems. Although the procedures for each instrument may be simple, the entire repertoire of communications methods for a complete experimental setup can easily baffle and dismay the programmer. Programs degenerate to an ill-structured network of procedure calls, timing loops, and code conversions, as a profusion of detail overwhelms the program's overall design.

Debugging these tangled, baroque routines is terribly frustrating. The toolbox restores clarity and explicitness to program structure by treating all devices on an equal footing. Toolbox programs never talk directly with any outside instrument. Instead, they communicate with small programs called *device drivers* that, in turn, communicate with the experiment's instruments and sensors.

Device drivers make programs



easier to understand and modify. Programmers can concentrate on the experiment without undue distraction from the computer's idiosyncrasies. Device drivers clarify program structure, since irrelevant details need not be represented explicitly. Programs are easier to understand, use, and revise. Documentation is easier to write, and its completeness is less crucial.

Communications between the programmer and the various device drivers are simple and standardized; all device drivers "look" pretty much the same. The device driver, in turn, understands and accommodates the special requirements of each device or instrument. Device drivers shield and protect the toolbox programmer from his confusing and ill-behaved array of instruments (see figures 1 and 2).

For example, different printers may require different character codes, signal levels, and control signals. Nonetheless, all printers are logically equivalent—they all accept characters from a computer and print them on paper. A toolbox program that uses a printer need not consider the details of the printer's interface or timing. Whenever a number must be printed, the program invokes the device driver { PRINT! }. If I replace the printer with a different model, I just revise { PRINT! }. All my programs will still work. If, on the other hand, every program communicated directly with the printer, I would have to modify every program. Indeed, I might need to modify every printer command in every program!

Device drivers help adapt the computer to the changing needs of its peripherals. To plot results on a chart recorder instead of printing them, for example, we need to make only slight changes. Chart recorders are logically equivalent to printers; they just accept numbers from the computer and

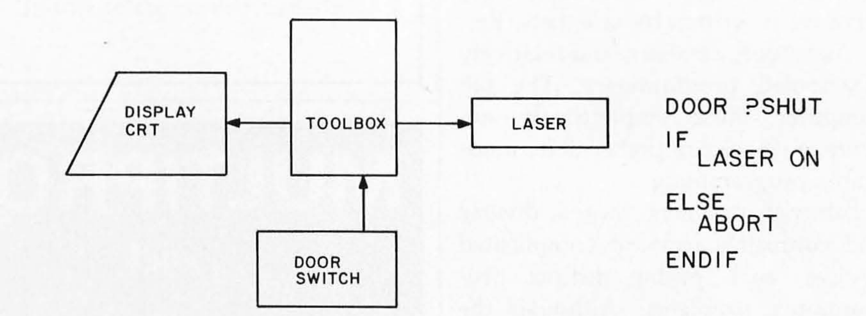


Figure 1: *Many scientists defeat the safety interlocks on their equipment because they simply get in the way too often. Simple additions to toolbox programs can help restore protection. Here, a few words prevent the laser from firing if the door is open.*

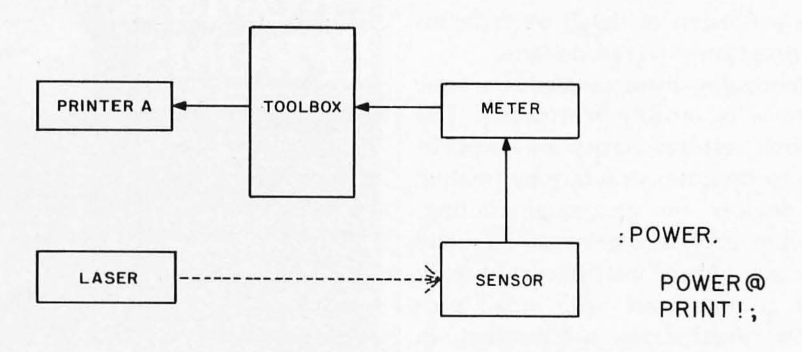


Figure 2: *This short program reads the laser's power and prints it. If I buy a new printer, I simply redefine { PRINT! } to work with the new machine. The old program still works with the new printer.*

put them onto paper. So, to use the chart recorder we simply replace { PRINT } with { PLOT } and, instead of printing a list of numbers, the computer will draw a graph of the experiment's results.

Device drivers can exchange data with instruments, other toolboxes, even with other computers. In fact, the (still hypothetical) device driver { TELEPHONE! } could connect an experiment to thousands of printers and computers throughout the world.

Programmers don't need to know all the details of every device's design and operation. Of course, the author of the device driver must understand these details, but, since device drivers are all used in pretty much the same way, anyone else can use the device driver.

Tables 2 and 3 describe several device drivers. Drivers that send a single number or character to an instrument have names that end in an exclamation point (!), like { PRINT! }. Drivers that receive a single number or character have names followed by an at sign (@). Device drivers that receive data from an instrument and display it immediately have names ending in a question mark (?), while device drivers that test an instrument's status, and that abort if an error has been detected, have names that *begin* with a question mark.

In fact, knowing the name of the device driver is often all that a programmer needs to know to use an instrument.

The FORTH Language

Many computer languages might be suitable for use in the toolbox. The language chosen must be implemented efficiently, especially because small computers tend to be slow and their memory space is often restricted. Invocation, the ability to execute a subprogram by naming it, is required for implementing the device drivers. Other features are convenient, but efficiency and invocation are not expendable.

These considerations exclude the two methods most commonly used to program small computers. BASIC does not support invocation, except

in a most primitive and unsatisfactory manner. Common BASIC interpreters, moreover, are too slow for many laboratory situations. Assembly language does not intrinsically support invocation either, although macroassemblers (which support invocation quite satisfactorily) are now available for many machines. Unfortunately, extensive use of macroinstructions only exacerbates the propensity of assembly language to produce very long programs. Few microcomputer assemblers can com-

Device Type	Quantity	Total Channels
parallel port	6	96 data bits 12 control signals
serial port	1	1 (300 bps)
AC power control	4	4 100-W channels
ADC	1	2 bipolar inputs 2 voltage inputs 4 resistor inputs 8 unbuffered inputs
DAC	2	2
IEEE-488 control bus	1	15
sound generator	1	1
graphics display	1	1
scratchpad memory	1	128 bytes
plotter	1	1 (uses DACs)
motor controller	1	1

Table 2: *The hardware complement of the author's computer toolbox.*

	Driver	Device	Purpose
Data-Transmitting Drivers	!	memory	stores number in specified location in memory
	PRINT!	printer	sends number to printer
	EMIT!	printer	sends character to printer
	DAC!	DAC	sends number to digital-to-analog converter
	VID!	TV camera	sends instruction to camera
	PLOT!	plotter	moves pen to specified coordinate
Data-Receiving Drivers	@	memory	retrieves number from specified location in memory
	THUMB@	thumbwheel	retrieves current thumbwheel setting
	VID@	memory	retrieves current TV camera programming instructions
	ADC@	ADC	requests measurement from analog-to-digital converter
	POINT@	digitizer	requests one coordinate-pair from the digitizer
IEEE-488 Bus Device Drivers	TALK	IEEE bus	transmits "talk" to an instrument
	UNTALK	IEEE bus	transmits "untalk"
	LISTEN	IEEE bus	transmits "listen" to an instrument
	UNLISTEN	IEEE bus	transmits "unlisten"
	IEEE@	IEEE bus	receives data byte from bus
	IEEE!	IEEE bus	transmits data byte over bus
Special Device Drivers	R/W	disk	reads and writes disk files
	CMOVE	memory	moves blocks of data in memory
	EDIT	disk/screen	creates and modifies disk files
	HOME	screen	returns cursor to top of screen
	FORWARD	motor	advances stepping motor
	ON	AC control	supplies power to outlet
	OFF	AC control	disconnects outlet
	TIME!	clock	sets the clock
	TIME@	clock	reads the clock

Table 3: *Some typical device drivers, based on the author's system.*

fortably develop programs comprising over a thousand instructions, but experiment controllers often exceed this size.

Several higher-level languages are suitable for programming the toolbox. APL's extraordinary facility for array and matrix calculation easily outweighs its handicaps. Pascal, C, or Ada might also be attractive. Even FORTRAN would be adequate, especially since many scientists already know FORTRAN; this consideration also applies to ALGOL-60 and its descendants.

Unfortunately, currently available microcomputers are rather slow, and thus they demand exceptional efficiency from the toolbox language. Compilers and interpreters for common languages do not now produce sufficiently fast programs and cannot be used. This situation will change as the power and speed of microcomputers improve.

We have used the FORTH language in our toolbox, with very satisfactory results. FORTH has been described in several articles in the August 1980 BYTE, in Ronald Loeliger's *Threaded Interpretive Languages* (BYTE Books, 1981), and in FORTH Inc.'s *Using FORTH*. More advanced but invaluable information is available from FIG (the FORTH Interest Group), which publishes assembly-language implementations of FORTH for many common microprocessors.

The FIG implementation of FORTH is extremely efficient in both space and speed. Although some common programming tasks are difficult to express clearly in FORTH, the language adapts unusually well to laboratory programming. In fact, FORTH was originally designed for just this application. FORTH interpreters are uniquely simple to test and to modify. Several writers report successful implementations of significant subsets of FORTH in only a few weeks. While FORTH is now commercially available for many computers, its easy implementation makes it a practical choice even if a commercial version is not available.

FORTH procedures communicate with each other by using a first-in, last-out stack (see figure 4). Toolbox routines use the *stack* to exchange information. For example, the routine ADC@ measures the input to the analog-to-digital converter, leaving the result on the stack. DAC! sends the number on top of the stack to the digital-to-analog converter, which produces a corresponding voltage.

ADC@ can talk to DAC! by using the stack; the program

```
ADC@  DAC!
```

reads a voltage at the analog input and transmits it to the analog output. Other programs transform data on the stack, accepting information from one routine, transforming it, and leaving the results for another routine. LOG, for instance, takes a number off the stack, calculates its logarithm, and leaves the result on the stack. The sequence

```
ADC@  LOG  DAC!
```

sets the output voltage to the logarithm of the input signal.

In FORTH, numbers are simply procedures that put their value onto the stack. "273" is the name of a procedure that leaves the value 273 on top of the stack. FORTH can work in any common base; the procedure HEX instructs FORTH to treat numbers as hexadecimal quantities, DECIMAL tells FORTH to use base ten, and BINARY makes FORTH use base two.

Building Toolbox Commands

A scientist controls an experiment by typing commands into the toolbox. Consider, for example, the simple problem of turning equipment on and off during the course of an experiment.

In Harvard's picosecond laser facility, toolbox hardware includes four 117-V AC outlets controlled by the computer. An experimenter might plug an oscilloscope into socket number 1, a meter into outlet 2, a signal generator into outlet 3, and a laser into outlet 4. At various times during the experiment, the computer must supply and remove power to these devices.

The device drivers for the AC power controller are named ON and OFF. ON and OFF connect and disconnect power to a specified outlet; the command

```
1 ON
```

supplies power to socket number one.

For flexibility and convenience, we might define a new command called SCOPE:

```
: SCOPE   1   ;
```

Whenever SCOPE is invoked, it leaves the value 1 (the scope's socket number) on the stack, so the command

A Note About FORTH

FORTH uses punctuation in some of its words, which makes representing them in text a difficult problem. For example, one FORTH word is ("), which could be taken to mean one of several character combinations. (For your information, the word has three characters and is made from a left parenthesis followed by a double quote mark and a right parenthesis.)

To decrease the chance of confusion while trying not to clutter text unnecessarily, we have used pairs of braces, { }, to isolate the character string within as a FORTH word or phrase. For example, the above word would be written { (") }. Braces have been used only in the following situations:

- *when the material being quoted is a phrase of FORTH words (e.g., { 26 LOAD } or { 35 + })*
- *with the FORTH words { . } (period), { , } (comma), { : } (colon), { ; } (semicolon), { ? } (question mark), { ! } (exclamation point), { ' } (single quote mark), and { " } (double quote mark)*
- *with any word using the above punctuation marks (e.g., { $. } or { ." }).*

All other FORTH words are set apart by a space on either side of the word. So, in this article, braces always signal a FORTH word or phrase. The braces are not part of the word or phrase, and FORTH words never use braces within the body of a figure or listing. . . . **GW**

SCOPE ON

energizes the oscilloscope. If we decide to plug the oscilloscope into some other socket, we simply change the definition of SCOPE. This "informs" all our programs of the change, so we don't have to hunt through every procedure, looking for references to socket number 1.

Commands can be issued singly or in a large burst. Several commands can be put on one line, or a single command can spread over many lines. Extra spaces, carriage returns, and tabs are harmless and make program listings more attractive and easier to follow. Part of an experimental session might read:

```
METER ON     SCOPE ON
         LASER ON
         5 MINUTES
         LASER OFF
```

This set of commands turns on the meter, oscilloscope, and laser, waits for five minutes, and then turns off the laser.

If I need to perform this sequence often, it is simple and convenient to group these commands into a single command:

```
: TEST
    METER ON SCOPE ON
    LASER ON 5 MINUTES
    LASER OFF  ;
```

Typing TEST tells the computer to perform the entire sequence. This particular sequence might be used to check whether all the instruments are working, and procedures called ALIGN, COLLECT-DATA, and SHUT-DOWN could be used for other parts of the experiment. In fact, TEST can be included as a part of another procedure.

Toolbox commands are easy to create. New commands cost only a few bytes of memory. Powerful and subtle commands can be built up from simpler ones. The toolbox actually encourages programmers to write convenient and comprehensible programs. Toolbox programs that are easy to write and modify are in-

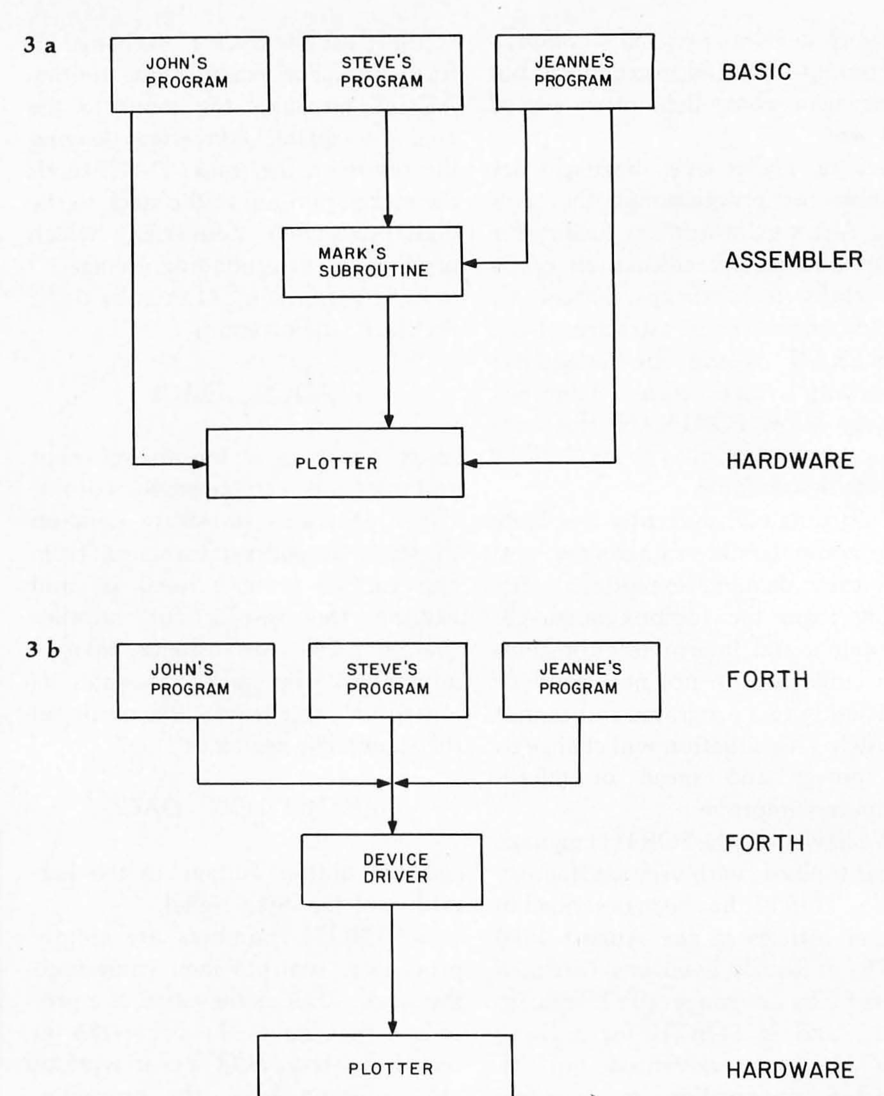


Figure 3: *In conventional environments, replacing one hardware device can require many software changes. If the plotter is replaced, many programs must be altered. In figure 3a, John and Jeanne must rewrite parts of their programs, and Mark has to rewrite the assembly-language subroutine Steve and Jeanne both use. If Mark leaves for a new job, Steve and Jeanne may be in serious trouble! As shown in figure 3b, the toolbox insulates users from software changes. If the plotter is replaced, the device driver has to be rewritten, but user programs don't need to be changed.*

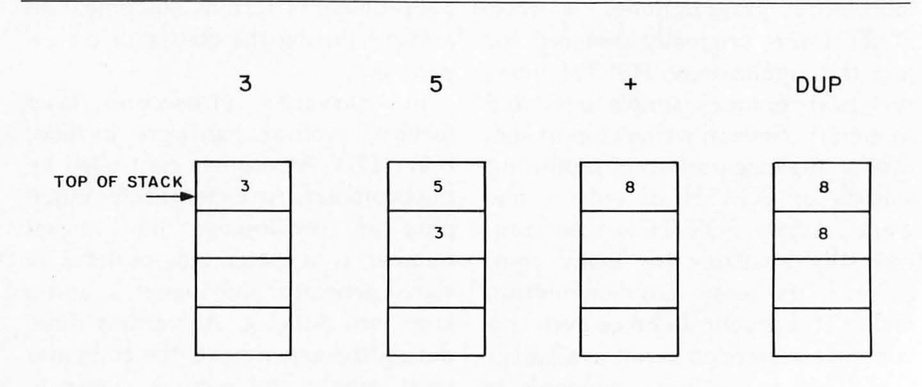


Figure 4: *Reverse Polish notation and the computation stack. Reverse Polish makes arithmetic look strange but can be perfectly natural for controlling machines.*

herently easy to use; man-machine dialogue is instrinsic in the program's structure, not tacked on as an afterthought.

Amenities

Scientists work in a number-filled world. Contrary to popular myth, though, most scientists have no special facility for arithmetic. In one Cambridge poker game, the regular players include three chemists, a physicist, a stock broker, and a lawyer. To rapidly count and split pots, all defer to the seventh player—an artist.

Since scientists generally can't do arithmetic any better than other people, lab computers should be able to do it for them. When an unexpected question comes up, the lab computer ought to double as a pocket calculator. Our toolbox provides this facility within the FORTH language, because FORTH can do arithmetic very much like any reverse-Polish calculator.

For example, to add 3 to 7 and print the result, we can simply type

```
3 7 + .
```

to which FORTH responds

```
10 OK
```

{ . } is the FORTH command to display the top value from the stack. FORTH's ability to use any common base is often very useful; to translate, say, hexadecimal 4AF to base ten, we simply type

```
HEX 4AF DECIMAL .
```

Clocks and timers are often useful. The command SECONDS instructs the toolbox computer to pause for a specified period. The time-of-day clock may be used (through its device drivers) to ascertain or set the current time. For example,

```
5 47 TIME!
```

sets the clock to 5:47. The command TIME@ reads the time, leaving the

current time on the stack. CLOCK? prints the time on the TV screen, using an attractive format. Special functions are easy to add; for example, CAL-TIME might print the time in California.

Interestingly enough, our toolbox "clock" is actually a small machine-language program. The device drivers for the clock are "driving" a completely mythical device! In practice, the clock's device drivers manipulate a few bytes of memory in which the clock program leaves the current time, but the user is free to believe that the clock is a hardware device inside the toolbox!

Someday we might just install an integrated circuit to replace the "clock" routine. To do that, we'd simply rewrite the device drivers. If a user did not notice the new integrated circuit inside the computer, he might never know about the new clock circuit.

The Toolbox Development System

The toolbox approach lets scientists apply computers to laboratory problems that tend to resist conventional design and programming methods. Moreover, developments in computer technology will substantially augment the potential of the toolbox in the next few years. Trends in microprocessor architecture favor designs that emphasize the toolbox virtues of modularity and invocation. A microprocessor designed specifically for efficient FORTH implementation, for example, is now under development. The toolbox relies heavily on its abundant input and output devices, and these, too, are subject to constant improvement.

Computer toolboxes are also uniquely suited to incorporate new advances in integrated-circuit technology. New parts can be plugged into the toolbox, often simply by connecting their pins to the appropriate signals on the system bus. New device drivers are easy to write and can use all the existing toolbox facilities.

For example, our toolbox currently includes programs to calculate logarithms. This job could be performed more effectively by an integrated-circuit arithmetic processor. Physically

installing such a device would require only a few additional integrated circuits. To install the processor in the toolbox *software*, we would write device-driver programs to control the math processor's operations. These programs could be written on the toolbox, using the existing toolbox software, and tested by comparing the results of the new and old logarithm routines.

Once a new device has been tested, existing toolbox programs may be modified to take advantage of the toolbox's new capabilities. This unusual flexibility suggests that the toolbox, designed to apply small computers to the scientific laboratory, may be a useful tool for developing computer systems! The toolbox makes no distinction between devices that happen to be inside or outside its box; everything is handled by device drivers. The toolbox, designed specifically to control many external devices, can also configure and control its own internal structure.

The toolbox may, like a snake, shed its skin of peripheral controllers, using them in the end only to create and test a new set of more powerful devices. If a better terminal becomes available, the old terminal can be used to write the new terminal's device drivers. An instrument designed this way could design and test its own successor—in fact, the new model could retain many of the old machine's parts and programs!

The toolbox is easy to customize and simple to modify. It can revise its own language and extend its vocabulary to meet the requirements of its user. It can be connected to many devices and can help test new interfaces and new instruments. In short, the toolbox is a very *personal* computer. ■

Acknowledgments

I'd like to express my gratitude and appreciation to Professor Kevin S. Peters, who patiently supported this work, and to the Merck Corporation for the honor of a Merck Corporation Foundation Fellowship.



Skip Sequential: A New File Structure for Microcomputers

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I still remember that fall day almost three years ago at Ecosoft, when we got our first floppy-disk drive up and running. Compared to the cassette system we had been using, it was the greatest thing since fire. It was at that point we began to think that the use of a microcomputer in serious business and research applications was a viable concept. It wasn't much longer before we were sure of it.

Like most disk systems, ours supported both random-access and sequential file structures. Depending upon the intended function, each has certain advantages and disadvantages. Sequential files use disk space very efficiently (an important consideration even with the increased storage capacity of double-density drives), but they are progressively slower on disk accesses as the file size grows. Random-access files are much faster on disk access, regardless of file size, but they require a fixed record length set to the maximum anticipated (i.e., "worst case") size. This often results in a considerable amount of wasted disk space.

The purpose of this article is to discuss a "new" file structure that we developed to help overcome some of the disadvantages associated with random-access and sequential files. The new file structure, which we have named Skip Sequential, is based on such a simple idea that many computerists will wonder why they didn't think of it. It is easy to use, adds little programming overhead, and offers significant advantages over conventional file structures. Although the text discusses Skip Sequential and its use in terms of North Star BASIC, we have also included listings for Microsoft's BASIC-80. Those familiar with BASIC-80 should have little difficulty implementing Skip Sequential.

Sequential and Random-Access Files

Before discussing Skip Sequential, it's important to understand the differences between random-access and sequential files. For purposes of illustration, let's assume that you need a program that will store: (1) the customer's name; (2) the amount paid for an item; (3) the date of the purchase; (4) the invoice number of the sale; and (5) a flag variable to reflect whether or not the invoice has been paid. Let's assume that the variables are:

We needed to overcome some of the disadvantages associated with random-access and sequential files.

D = Date Sold
N = Invoice Number
A = Amount of the Sale
N$ = Customer's Name
F = "Paid" flag
(F=1 is "Not Paid")

This data could be easily stored using either sequential or random-access files. Let's examine these two possibilities.

An Example Using Sequential Files

The program in listing 1 is an example of storing data with sequential files. It is assumed that the values of the variables were determined elsewhere in the program. (If these were actual subroutines, the END statements would be RETURNs.) Line 230 opens the file to be read, while line 240 looks for an end-of-file mark using the TYP command. In North Star BASIC, a unique type will be associated with the data: if it is a string variable, TYP returns a value of 1; if it is a numeric variable, TYP will equal 2; and, if it is an end-of-file mark, TYP returns with a 0. If line 240 finds that TYP is not equal to 0, it falls through to line 250 and reads the data in the file into a set of dummy variables. (Dummy variables must be used so that we don't destroy the new data that we want to add to the file.) Once the end-of-file is found, the branch in line 240 is executed and we write the new data to the file (line 270).

Note that as new transactions are entered, more and more time is spent in the loop formed by lines 240 through 260 looking for the end-of-file mark. Because sequential files require that the entire data file be read before any new data can be written, the time lost looking for the end-of-file is a major limitation of sequential files. On the other hand, a sequential file is a "dense" file (i.e., there are no

wasted gaps in the file). Each new piece of data is tightly packed against the previous piece of data, so disk space is used very efficiently. However, the programmer must decide between optimal use of disk space or faster operation: a choice that usually dictates use of random-access files.

Listing 1: *This routine, written in North Star BASIC, adds a record to the end of an existing sequential file.*

```
100 REM=====================================================================
110 REM    This is an example of a sequential file for North Star DOS
120 REM                          and Basic
130 REM
140 REM                          10-15-80
150 REM                           Purdum
160 REM                           Ecosoft
170 REM=====================================================================
180 REM
190 REM   This program is treated as a subroutine where the values of the
200 REM           variables are determined before entering it.
210 REM
220 REM
230 OPEN #0,"BYTE"\REM                              Activate file
240 IF TYP(0)=0 THEN 270
250 READ #0,D1,N1,A1,N1$,F\REM                      Read dummies if data present
260 GOTO 240
270 WRITE #0,D,N,A,N$,F\REM                         Found E.O.F.,write new values
280 CLOSE #0
290 !"END"\END
```

Listing 2: *This routine adds a new record to a random-access file. The number of records in this file is stored at the beginning of the file and updated after each write operation.*

```
100 REM=====================================================================
110 REM    This is an example of a random access file for North Star
120 REM                          DOS and Basic
130 REM
140 REM
150 REM                          10-15-80
160 REM                           Purdum
170 REM                           Ecosoft
180 REM=====================================================================
190 REM   This program is also treated as a subroutine where the values
200 REM         of the variables are determined before entering it
210 REM
220 REM
230 OPEN #0,"BYTE"
240 READ #0,R\REM                                R contains # of records on disk
250 WRITE #0%(52*R+5),D,N,A,N$,F
260 R=R+1\REM                                    Update record count
270 WRITE #0%0,R,NOENDMARK
280 CLOSE #0
290 END
```

An Example Using Random-Access Files

Listing 2 presents the same type of program as that shown in listing 1, but using random-access files. A major difference between the two programs is that random-access files must use a fixed record length (i.e., each transaction will use exactly the same number of bytes in all instances). The programmer must decide this length, and in making that determination needs to know the following: how many bytes are required to store a numeric variable; how many bytes should be allocated to store string data (including any "overhead" bytes associated with such string variables); and how many numeric and string variables will be used in each record. In our example, we use four numeric variables (D, N, A, and F) and one string variable (N$).

The first task is to determine how many bytes are needed for each floating-point number stored in the numeric variables. For North Star BASIC, this can be determined by the following equation:

$$B = (P/2) + 1$$

where:

B = the number of bytes in a floating-point number

P = the precision of the BASIC

For the standard version of North Star BASIC (8-digit precision BASIC), each floating-point number requires 5 bytes.

To determine the requirements for the name field, the programmer must decide on a string length that will be long enough to hold most customer names, but not so long as to waste unnecessary disk space. In our example, we selected 30 bytes for the name string (N$). It should be noted that North Star BASIC requires 2 overhead (or *housekeeping*) bytes for each string that is less than 255 bytes long (3 bytes are required if the string is longer than 255 bytes). We can now determine the fixed record length for the random-access file, as shown in table 1.

Variable	Type	Bytes	Overhead
D	Numeric	5	-0-
N	Numeric	5	-0-
A	Numeric	5	-0-
N$	String	30	2
F	Numeric	5	-0-
	Totals:	50	2
	Record Length: 52		

Table 1: *To calculate the fixed record length for a random-access file, simply sum the number of bytes required by each variable (or field) within a record.*

Having determined the fixed record length, the programmer can proceed to write the program (see the example shown in listing 2). We have assumed that the programmer has written a 0 (zero) to the file for R (the variable that informs the program of how many previous transactions have been written to the disk). Since R is a floating-point number, the file has 5 bytes in it before it is even used. The

percent sign (%) in line 250 of listing 2 is interpreted to mean "jump the following number of bytes" and write the new record. If this is the first entry, the program will jump over 0 × 52 bytes, plus 5 more bytes. Since 0 × 52 is 0, the program jumps over 5 bytes (jumps over the R variable) and writes the new data. Line 260 increments the record count in R and writes the new value of R at the beginning of the file (the %0 says to jump over 0 bytes, hence rewriting R). The NOENDMARK command informs the interpreter not to write an end-of-file mark after updating R. If the end-of-file mark was written after R, the program would think that the file ended after the first 5 bytes.

The advantage of random-access files is that we don't have to read through the entire file to perform a write operation. By simply reading R and jumping the correct number of bytes (lines 240 and 250 in listings 2), we know exactly where the new data should be written. There is a price to pay for the increased speed, however. If a customer's name is "W. Oz", which is only 5 bytes long including the blank, we must still allocate 30 bytes because of the fixed record requirement of random-access files. We have wasted almost 50% of the record space, a circumstance that is of particular importance when working with the smaller capacities of 5-inch floppy disks. Even the end user might get a little cranky if he knew that half of his disk space was going to waste.

Skip Sequential: The Best of Both Worlds

The main advantage of a Skip Sequential file is that it has the same speed as a random-access file, but does *not* require the use of fixed record lengths. This means that it can write data to the disk with the same speed as random access, but does so without wasting disk space. If a customer's name is 5 bytes long, it will use only 5 bytes. We've been using Skip Sequential for almost three years and have virtually eliminated sequential files from our programming choices. In all but the most trivial cases, Skip Sequential beats sequential files, hands down.

Listing 3: *Initializing a Skip Sequential file requires that a single number be written to the file. Since this number will serve as the file byte counter, and is itself 5 bytes long, it is set to 5 on initialization.*

```
100 REM===================================================================
110 REM      Initialization routine for Skip Sequential prior to use
130 REM
140 REM
150 REM                                  10-15-80
160 REM                                   Purdum
170 REM                                   Ecosoft
180 REM===================================================================
190 REM    This program write a single number to a SS data file, the value
200 REM    of which is equal to the number of bytes/floating point number.
210 REM
220 REM
230 OPEN #0,"BYTE"
240 X=5\REM                                 We're assuming 8-digit precision
250 WRITE #0,X
260 CLOSE #0
270 END
```

Skip Sequential is easy to use and requires little programming overhead. Essentially, it is a random-access file with a fixed record length of 1 byte: all we have to do is keep track of the number of bytes already written to the file. To this end we must provide a byte counter when the file is initialized (before using Skip Sequential). The program in listing 3 illustrates this process.

When preparing a file for Skip Sequential, you must first write a single number to the file. The value of that number depends upon the number of bytes required for a floating-point number. North Star BASIC, for example, uses 5 bytes for such numbers, so X in line 240 of listing 3 is set to 5. Line 250 writes the number 5 to the file, and the program ends. Why do we have to write this number? Since we must keep track of the number of bytes written to the file, and the counter is a number which is 5 bytes long, 5 bytes are written to the file when we write the byte counter in line 250. The program in listing 3 has done what it's supposed to do: keep track of the number of bytes in the file—exactly 5. Having initialized the byte counter, we are now ready to use the file.

The program in listing 4 can be used to implement the sample program discussed earlier. Line 240 reads the byte counter, while line 260 says to "skip over" B bytes and then write the new data to the disk. The first time through, B will equal 5 bytes, since only the byte counter is in the file. Note that North Star BASIC "skips" with respect to the beginning of the data file; some operating systems may do this with respect to the disk head after reading B. If this is true, the byte counter must be initialized to 0 in listing 3. Once the skip is performed in line 260, the new data is written to the disk in the conventional manner.

Disk space is saved through line 270, which sets L equal to the length of N$. Line 280 increases the byte counter to reflect the number of bytes written to the disk. Since there are four numbers of 5 bytes each, this is added to B, plus the length of the string, L, plus the 2 overhead bytes associated with each string. If the name were "W. Oz", L would equal 5, and the total number of additional bytes would be 27. The byte counter would reflect 32, the total number of bytes in the file (27 new bytes plus 5 for the byte counter itself). Line 300 then writes the new value of the byte counter to the beginning of the file.

Note what happens in listing 4 when a second entry is made to the file. Line 240 returns with 32 in B. The program then skips over 32 bytes in line 260 and writes the new transaction in the proper place in the file. The disk-write operation is actually performed faster than the random-access example given earlier, since B does not have to be calculated. Fixed record lengths are not used, so we save the difference between the actual string length and the worst case string length that would have been used with random-access files. As the file grows longer, the savings can be substantial.

It is quite simple to read the file

Listing 4: *New records may be added to a Skip Sequential file with this routine. The length of each record varies with the length of N$, the string variable containing a customer name.*

```
100 REM===================================================================
110 REM  This is an example of a Skip Sequential file for North Star
120 REM                           DOS and Basic
130 REM
140 REM
150 REM                             10-15-80
160 REM                              Purdum
170 REM                              Ecosoft
180 REM===================================================================
190 REM   This program is also treated as a subroutine where the values
200 REM         of the variables are determined before entering it
210 REM
220 REM
230 OPEN #0,"BYTE"
240 READ #0,B\REM                          B contains # of BYTES written to disk
250 REM
260 WRITE #0%B,D,N,A,N$,F\REM              Skip over the bytes already on disk
270 L=LEN(N$)
280 B=B+(5*4)+L+2\REM                      Up B by number of new bytes written
290 REM
300 WRITE #0%0,B,NOENDMARK\REM             Now update byte counter
310 CLOSE #0
320 END
```

Listing 5: *Each record of a Skip Sequential file is read by calculating the individual record lengths as they are read and adding this value to the current byte count.*

```
100 REM===================================================================
110 REM  This program reads a Skip Sequential file using North Star DOS
120 REM                           and Basic
130 REM
140 REM
150 REM                             10-15-80
160 REM                              Purdum
170 REM                              Ecosoft
180 REM===================================================================
190 REM
200 REM
210 REM
220 DIM N$(30)
230 E=5\REM                                  Must set a variable, E, equal to the number
240 REM                                      of bytes per floating point number.
250 OPEN #0,"BYTE"
260 READ #0,B
270 READ #0,D,N,A,N$,F
280 !D,TAB(10),N,TAB(20),A,TAB(30),N$,TAB(65),F
290 L=LEN(N$)
300 E=E+(5*4)+L+2
310 IF E<B THEN 270
320 !\!"END OF LISTING"
330 CLOSE #0
340 END
```

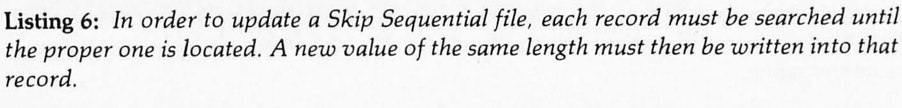
using sequential techniques. An example is given in listing 5. Note that E is equal to 5 in line 230. By using this variable in the same manner as B in listing 4, a comparison of E and B (as in line 310) is equivalent to testing for an end-of-file mark. Since E is updated in line 300, we know that we have read all of the data in the file when E is equal to B.

The program in listing 5 does point out one potential problem. In those cases where N$ might be empty, line 270 expects to see an N$ in the file. The simplest way to avoid a type error on a read operation is to set N$ equal to one blank before writing it to the disk in listing 4. While this does waste 3 bytes, the loss is trivial compared to the other savings of the Skip Sequential method.

Updating a Skip Sequential File

Another advantage of Skip Sequential over sequential files is that they can be updated almost as easily as random files. Suppose that we want to use the flag variable (F) to reflect whether or not the transaction is paid. Assuming the F equaled 1 when the transaction was originally written, we now want to update it to a paid status. We will further assume that the new value of F will reflect the date it was paid (although it could be a check number or any other numeric data). Listing 6 contains an example of updating a Skip Sequential file.

Line 250 again sets the end-of-file counter, E. Lines 270 through 310 read the data and update E. Line 330 asks if this is the proper invoice number. If it isn't, line 350 is executed: this tests



Listing 6: *In order to update a Skip Sequential file, each record must be searched until the proper one is located. A new value of the same length must then be written into that record.*

```
100 REM==========================================================================
110 REM  This program updates a variable in a Skip Sequential files using
120 REM                    North Star DOS and Basic
130 REM
140 REM
150 REM                              10-15-80
160 REM                               Purdum
170 REM                               Ecosoft
180 REM==========================================================================
190 REM    This program assumes we want to set the flag variable, F, to
200 REM    equal the current date, which is held in variable Y. The trans-
210 REM    action to be updated has an invoice number that must match N1.
220 REM
230 REM
240 DIM N$(30)
250 E=5\REM                             Must set a variable, E, equal to the number
260 REM                                 of bytes per floating point number.
270 OPEN #0,"BYTE"
280 READ #0,B
290 READ #0,D,N,A,N$,F
300 L=LEN(N$)
310 E=E+(5*4)+L+2\REM                   Update number of bytes read, variable E
320 REM
330 IF N=N1 THEN 430\REM                Is it the one we're looking for?
340 REM
350 IF E<B THEN 290\REM                 Compare to B to see if we've read all bytes
360 !\!"CANNOT FIND A MATCH FOR INVOICE NUMBER",N
370 CLOSE #0
380 END
390 REM                                 **********   Update Flag   ***********
400 REM                                 Since F is the last variable read and E con-
410 REM                                 tains the number of bytes read, back up 5
420 REM                                 bytes and write the date paid.
430 WRITE #0%(E-5),Y,NOENDMARK
440 CLOSE #0
450 !"INVOICE MARKED 'PAID' WITH TODAY'S DATE."\!
460 END
```

Listing 7: *Microsoft BASIC-80 version of the initialization routine for a Skip Sequential file.*

```
100 REM==========================================================================
110 REM Skip Sequential files for Digital Research's CP/M operating system and
120 REM                      Microsoft's Basic-80.
130 REM
140 REM                            10-15-80
150 REM                        Purdum, ECOSOFT
160 REM==========================================================================
170 REM
180 REM      The function of this program is to initialize the data file
190 REM      called BYTE for use as a Skip Sequential data file. It assumes
200 REM      double-precision numbers are used in the data file.
210 REM
220 OPEN "R",#1,"BYTE",8:REM                 A random file with a fixed record
230 REM                                      length of 8 bytes.
240 FIELD #1,8 AS Y$
250 M=1:REM                                  One record will be in it
260 LSET Y$=MKD$(M)
270 PUT #1,1:CLOSE #1:END
```

for an end-of-file condition. If we haven't read all of the data, we go to 290 and read some more. If the proper match is in 330, control is sent to 430 to write today's date (assumed to be in Y) in place of F. Note how this is accomplished. Upon finding a match in 330, E contains the number of bytes read thus far. Since F is a 5-byte number, we need to back up 5 bytes before writing Y in place of F. For this reason, five is subtracted from the variable E in line 430. The rest of the line writes the date, Y, *with no end-of-file mark*, to the file. We are, of course, assuming that Y is also a number.

Skip Sequential for BASIC-80

We have also included a program similar to the above but modified for Microsoft's BASIC-80. The program listings are similar to the North Star BASIC versions, but the differences between interpreters do require some changes.

One of the major differences between North Star BASIC and BASIC-80 is that BASIC-80 requires that record length be given when the file is opened. Listing 7 shows how a Skip Sequential file is initialized using BASIC-80. Since we use dollar amounts as one of the variables in the data file (i.e., A), the programmer will

Listing 8: *BASIC-80 routine to add a record to a Skip Sequential file. Note that this routine uses an 8-byte record length instead of the 1-byte length used in North Star BASIC.*

```
100 REM===============================================================
110 REM            Writing data to a Skip Sequential data file
120 REM                         CP/M and Basic-80
130 REM
140 REM                            Purdum, Ecosoft
150 REM                              10-15-80
160 REM===============================================================
170 REM
180 REM     The function of this program is to write the data to the SS file
190 REM     called BYTE. It assumes values are given upon entering the routine.
200 REM
210 REM
220 IF LEN(N$)=0 THEN N$=SPACE$(8):REM       If no name wanted, write 8 blanks
230 REM
240 REM                                      Begin file write
250 REM
260 OPEN "R",#1,"BYTE",8:FIELD #1,8 AS Y$
270 REM
280 GET #1,1:U=CVD(Y$):U=INT(U):REM          Get # of records already in file in U
290 U=U+1:REM                                Up counter
300 REM
310 LSET Y$=MKD$(D):PUT #1,U:REM             Write a new one, D
320 U=U+1
330 LSET Y$=MKD$(N):PUT #1,U:REM             Another one, N
340 U=U+1
350 LSET Y$=MKD$(A):PUT #1,U:REM             Yet another,A
360 U=U+1
370 REM           *** Now find how many records needed for N$ ***
380 REM
390 IF LEN(N$)/8>INT(LEN(N$)/8) THEN X=INT(LEN(N$)/8)+1 ELSE X=INT(LEN(N$)/8)
400 REM
410 LSET Y$=MKD$(X):PUT #1,U:REM             Save number of records, X
420 REM
430 REM                                      Now write N$ as 8-byte records
440 FOR J=1 TO X
450   LSET Y$=MID$(N$,8*J-7,8)
460   PUT #1,J+U
470 NEXT J
480 REM
490 U=U+X
500 F=1:REM                                  Add flag variable, F=1=active
510 U=U+1
520 LSET Y$=MKD$(F):PUT #1,U
530 LSET Y$=MKD$(U):PUT #1,1:REM             Update counter for new records added
540 CLOSE #1
550 END
```

Listing 9: *BASIC-80 program to read data in a Skip Sequential file.*

```
100 REM===============================================================
110 REM    This program reads the Skip Sequential file for CP/M and
120 REM                        Basic-80
130 REM
140 REM                        10-15-80
150 REM                      Purdum,ECOSOFT
160 REM===============================================================
170 REM        This is also treated as if it were a subroutine
180 REM
190 OPEN "R",#1,"BYTE",8:FIELD #1,8 AS Y$
200 GET #1,1:U=CVD(Y$):REM                 Get record counter in U
210 REM
220 M=2:REM                                We want second record
230 GET #1,M:D=CVD(Y$):REM                 Get date
240 M=M+1
250 GET #1,M:N=CVD(Y$):REM                 Get Invoice number
260 M=M+1
270 GET #1,M:A=CVD(Y$):REM                 Get amount
280 M=M+1
290 GET #1,M:X=CVD(Y$):REM                 Get byte-lenght of customer name in
300 REM                                    terms of 8-byte records into X
310 FOR J=1 TO X
320   GET #1,M+J:N$=N$+Y$:REM              Stuff name in N$
330 NEXT J
340 M=M+X:REM                              Bump read counter for N$ length
350 M=M+1
360 GET #1,M:F=CVD(Y$):REM                 Get flag and we're done
370 IF M<>U THEN 200
380 CLOSE #1:END
```

probably want to use double-precision numbers. In BASIC-80, 8 bytes are required for each numeric variable. Lines 220 and 240 inform the interpreter that we will be using a fixed record length of 8 bytes instead of the 1-byte record in the North Star BASIC version of Skip Sequential (Microsoft BASIC-80 does not allow a record length of 1). Line 260 con-

verts the value of M into a string for writing to the disk. This is essentially identical to the use of random-access files in North Star BASIC to this point.

Listing 8 illustrates how the data is written to the Skip Sequential file. The only unusual part of the program occurs betweens lines 390 and 480. Line 390 makes the name held in N$ an even multiple of 8 bytes. The value of X tells us how many multiples there are, and since we need to know this X value later to read N$, line 410 saves it in the file as part of the transaction. Lines 440 through 480 save N$ to the disk as 8-byte records. The remainder of the program is the BASIC-80 equivalent of writing the flag variable and the updated record counter.

Listing 9 is the program to read the Skip Sequential file. The only unusual segment is the reconstruction of N$ in lines 310 through 330. The updating need not be discussed, since it would be identical to updating any other random file in BASIC-80.

Several improvements could be made to the BASIC-80 version. For example, X could be "packed" with the date, given the double-precision numbers of BASIC-80 and the fact that X will never exceed four in the sample program. We also think that there may be a way to trick the interpreter into accepting a 1-byte record length instead of 8 bytes, but we haven't experimented sufficiently. Still, Skip Sequential can save disk space over conventional random-access files, albeit the savings aren't quite as great.

Concluding Thoughts

Skip Sequential files do offer many advantages to the programmer and, indeed, the end user. In general, Skip Sequential files may be used for the following: in almost any application where ordinary sequential files are appropriate; in any situation where data is archival in nature (e.g., data backups, transactions, or historical entries); and where only limited updating is required (e.g., setting flags). As a general rule, Skip Sequential strings cannot be updated unless the new and old string lengths are the same. For this reason, data sets that require frequent updating, such as mail or customer lists, are better suited to random-access files.

Finally, Skip Sequential files can be used in a way that simulates ISAM (indexed-sequential access method) files. For example, if a separate file holds the byte-counter values that exist for the first entry of each month, those byte-counter values can be read first and used to jump to the first entry of the month in the Skip Sequential file. This will further enhance the speed of data retrieval.

While the documentation for the Skip Sequential method has been copyrighted, and we have applied for a trademark on the name, I encourage you to make use of the files. If you plan to make commercial use of the Skip Sequential method, I'd appreciate it if you would contact us first.■

Acknowledgments

I would like to thank my business associate and friend, Dr. J. B. Orris, for his comments on an earlier draft of this article.

Finding Words That Sound Alike

The Soundex Algorithm

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The name I am searching for is "Johnson." But is it spelled "Johnson," "Johnsen," "Jonson," "Jonsen," or "Johanson"? The Soundex algorithm can help find words that sound alike by reducing a string to a Soundex code string consisting of a letter and up to three digits.

Alphabetic strings that sound alike generate identical Soundex code strings. The Soundex system is used in the Whatsit data-management system (from Computer Headware, POB 14694, San Francisco, CA 94114) that runs on the Apple, but the program presented here is my own. In the Whatsit program, you can ask, "WHAT SOUNDS (LIKE) JOHNSON?" Whatsit then lists every word it "knows" that sounds like the word "Johnson."

The Soundex algorithm was recently described by P.A.V. Hall and G.R. Dowling ("Approximate String Matching," *ACM Computing Surveys*, 12, 4, December 1980, p. 388), and it works as follows. We will call the entry-name string E$ and the reduced output code string R$. The first character of R$ is merely the first character of E$. The remaining letters of the E$ string are replaced by their group code numbers as shown in table 1. Then all zeros are removed, and consecutive occurrences of the same digit are reduced to a single digit. Finally, the code is truncated on the left to leave one letter and up to three digits.

The Soundex program in listing 1 is written in Applesoft BASIC. To simplify conversion to other BASICs, I will give examples of the Applesoft MID$ and LEFT$ functions. A$=MID$(B$,6,4) will set the string variable A$ to a four-character substring of B$ starting at the sixth character. A$=LEFT$(B$,2) will set A$ to the first two (i.e., leftmost) characters of B$.

The Soundex subroutine beginning at line 1000 of listing 1 will accept the input string E$ and return the reduced-code string R$, and it will throw away nonalphabetic characters. Lines 10 through 40 dimension the arrays E$ and R$, which are used for demonstration purposes only. The array W(N) is initialized to the group number corresponding to the Nth letter of the alphabet.

Listing 1: *Written in Applesoft BASIC, this program accepts a character string E$ as input, converts it to the Soundex code string R$, and prints out all words that have the same code string.*

```
10 J = 0
20  DIM E$(99),R$(99)
30  DIM W(26)
40  FOR I = 1 TO 26: READ W(I): NEXT
50  PRINT : INPUT "INPUT STRING: ";E$: PRINT
60  GOSUB 1000
70 J = J + 1
80 R$(J) = R$
90 E$(J) = E$
100  FOR M = 1 TO J
110  IF R$(M) = R$ THEN  PRINT E$(M)
120  NEXT
130  GOTO 50
1000  REM SOUNDEX SUBROUTINE
1010 L =  LEN (E$)
1020 S$ = ""
1030 R$ =  LEFT$ (E$,1)
1040 ST = 0
1050  IF L < 2 THEN  RETURN
1060  FOR I = 2 TO L
1070 C =  ASC ( MID$ (E$,I,1))
1080  IF C < 65 OR C > 90 GOTO 1120
1090 C = C - 64
1100 W = W(C)
1110  IF W <  > 0 THEN S$ = S$ +  CHR$ (W + 48)
1120  NEXT
1130 L =  LEN (S$)
1140  IF L = 0 GOTO 1210
1150  FOR I = 1 TO L
1160 C =  ASC ( MID$ (S$,I,1))
1170  IF C <  > ST THEN R$ = R$ +  MID$ (S$,I,1)
1180 ST = C
1190  NEXT
1200  IF  LEN (R$) > 4 THEN R$ =  LEFT$ (R$,4)
1210  RETURN
1220  DATA 0,1,2,3,0,1,2,0,0,2,2,4,5,5,0,1,2,6,2,3,0,1,0,2,0,2

]
```

For example, W(3) contains the number 2 corresponding to the assignment of the letter C (i.e., the third letter of the alphabet) to the group 2. This initialization occurs in line 40, using the data statement in line 1220, and should be done once at the beginning of your main program.

Lines 50 through 130 form a simple demonstration program that stores each word as it is typed in together with its code word. The original word and the code word are stored in arrays E$( ) and R$( ), respectively. Each time you add a word, the program prints out all words that have the same code word, finding them by doing a linear search through the code words.

The Soundex Subroutine

The Soundex subroutine appears in lines 1000 through 1220. Lines 30 and 40 are also needed to initialize array W. The first letter of E$ is put into R$. If the length of E$ is 0 (null string) or 1, then the subroutine terminates (line 1050). Otherwise each character of E$, starting at the second character, is scanned and its group code is put into the intermediate string S$ unless the character is not a letter or the letter falls in group 0. For example, if we type SOMMERSET, when the program gets to line 1130, S$ will contain S55623. Next, consecutive occurrences of the same group number will be reduced to a single occurrence of that number. Thus the 55 in S55623 will become a single 5. When the program gets to line 1200, the string R$ will be S5623. Line 1200 truncates the string R$ to four characters, becoming S562, which is the code word for SOMMERSET. Let's take another look at the steps, shown *before* the execution of each line:

line	S$	R$
1030	null	S
1130	55623	S
1200	55623	S5623
1210	55623	S562

Group	Letters
0	A E I O U H W Y
1	B F P V
2	C G J K Q S X Z
3	D T
4	L
5	M N
6	R

Table 1

This algorithm has some serious limitations. Although our "Johnson" examples work fine, with the resulting code for the different spellings being J525, "phone" and "fone" do not give the same code because they start with different letters; "Rogers" and "Rodgers" do not work because the *d* is not in the same code group as *g*. And words like "tough" and "tuff" do not translate to the same code because *g* and *f* are in different code groups. But the Soundex algorithm works well for most words and proper names.

To try the Soundex algorithm, enter the program in listing 1 and run it. Type in some names. Every time you type a new name, the program will list on the screen all the words entered that have the same Soundex code. If you add the line

```
65 PRINT R$
```

the Soundex code will also be printed.

Applications

The Soundex subroutine has many applications. If you have a card-file program that searches for items by matching a "key" string, rather than returning the message

MATCH NOT FOUND

or some such, your program could jump into the "Soundex mode," look for matches that sound similar to the key, and then list them. You could then look through the list of near matches to see if the word sought is in the list. This short Soundex subroutine can add a lot of "flash" to what might otherwise be a mundane program. ■

SYSTEMS

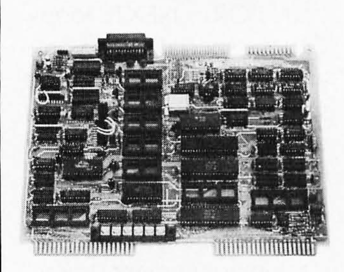


Multifunction Desktop Computers

The AWS family of multifunction work stations offer 0.5 megabyte of storage. These desktop work stations are based on the 16-bit Intel 8088 microprocessor and carry a combination of floppy- and Winchester hard-disk drives in the same enclosure as the processor and the display screen. Each AWS work station supports up to 512K bytes of RAM (random-access memory) based on 64K-byte RAM integrated circuits, an 80-character by 28-line video-display unit, and an optional mass-storage unit. The units can function as stand-alone terminals or as members of a local network by means of a high-speed data link, sharing peripherals and databases.

In single-units, the AWS work station ranges in price from $3990 to approximately $11,500, depending on optional equipment. For additional details, contact Pauline Alker, Convergent Technologies, 2500 Augustine Dr., Santa Clara, CA 95051, (800) 538-7560; in California (408) 727-8830.

Circle 550 on inquiry card.



Single-Board Computer Can Support 56K Bytes of Memory

The Flexi Plus is a 6809-based single-board microcomputer that can accommodate up to 56K bytes of on-board RAM (random-access read/write memory), ROM (read-only memory), and EPROM (erasable programmable ROM) in any combination. Flexi Plus features extensive serial and parallel I/O (input/output) capabilities, a 20-milliampere current-loop TTY (teletypewriter) port, and a universal cassette interface. When used without its 6809 option, the Flexi Plus can serve as an expansion board for most 6502-, 6800-, or 6809-based systems.

Optionally, the Flexi Plus can be expanded to include an IBM-format-compatible floppy-disk controller that can support up to four 8-inch drives or three 5¼-inch drives. Additional options include an IEEE-488 bus controller and a fully buffered RS-232C communications port with programmable data formats and transfer rates from 50 to 19,500 bps (bits per second).

The Flexi Plus costs $320. The 6809 and the RS-232C options are available for $75 each. Both the floppy-disk and the IEEE-488 bus controllers cost $125. Literature is available on request. Contact Robert M. Tripp, The Computerist Inc., 34 Chelmsford St., Chelmsford, MA 01824, (617) 256-3649.

Circle 551 on inquiry card.

STD Bus Controller Card

The ZT7805 controller card for the STD bus features an 8085A microprocessor, 1K bytes of programmable memory, up to 8K bytes of ROM (read-only memory), IEEE-488 I/O (input/output) and two serial RS-232C ports, and a control monitor with I/O subroutines. The board costs $650. Contact Ziatech Corp., 2410 Broad St., San Luis Obispo, CA 93401, (805) 541-0488.

Circle 552 on inquiry card.

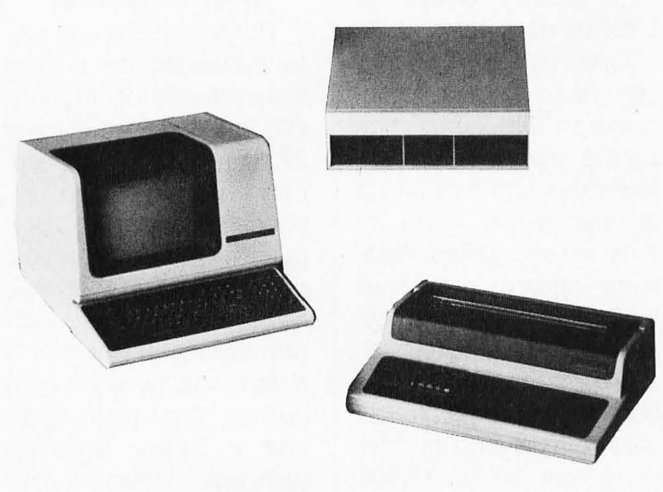
Modular Microcomputer

The Sintel-85 is a modular microcomputer training system based on the Intel 8085 microprocessor. It has 2K bytes of ROM (read-only memory) with expandable monitor, 256K bytes of RAM (random-access read/write memory), three programmable I/O (input/output) ports, a 6-digit display with both address and data fields, and a 24-key keyboard with eight command keys and 16 hexadecimal keys.

Sintel-85 can be expanded to include up to 64K bytes of memory and 256 I/O ports. A wide range of expansion and interface boards are available, including A/D (analog-to-digital) and D/A (digital-to-analog) converters, cassette interface, an immediate expansion board, and audio-visual I/O ports interface. The immediate expansion board augments the basic system with additional RAM, 4K bytes of EPROM (erasable programmable ROM), two counter/timers, and 44 programmed I/O lines. It includes two 8156 units, two 2114 static RAMs, and sockets for two 2716 ROMs. Also available is an I/O expansion board that lets you exercise and simulate I/O instructions, external systems operation, and program debugging. An oscillator lets you oper-

ate a small speaker. For more details, contact Beth Belkin, Government of Israel Trade Center, 350 Fifth Ave., New York, NY 10118, (212) 560-0661. In Israel, contact Sintel Systems Ltd., 13 Ovadia St., POB 9209, Haifa, Israel 34564, (04) 334944; Telex: 46400 BXHA IL, ext. 8134.

Circle 553 on inquiry card.



Business System Has Three Z80s

The ARCmicro is a small-business microcomputer system with three separate Z80 microprocessors: the system processor, the disk processor, and the terminal processor. The system supports two 5¼-inch Winchester disks for a total of 20 megabytes of formatted storage and four 5¼-inch double-sided, double-density floppy-disks totaling 3.2 megabytes of storage. System memory is expandable from 64K bytes to 256K bytes. The terminal processor controls all video-display units, printers, and communications links with the system processor, which frees the system processor from interrupts and increases communications throughput.

Other features of the ARCmicro include a shadow ROM (read-only memory) that contains self-diagnostics and bootstrap programs that execute during system initialization. The self-diagnostic programs perform memory and peripheral device tests to assure integrity each time the system is initialized. The ROM then "disappears" from the address space and is available for use by the program memory.

The ARCmicro is currently available as a complete microcomputer system called the ARCmicro/PAC, which includes a DEC (Digital Equipment Corporation) VT-101 video display, a DEC LA-34 printer, and either the CP/M 2.2 or the MP/M II disk operating system. Contact ARC Automation Group Inc., POB 1009, Bryan, TX 77805, (713) 693-6122.

Circle 554 on inquiry card.

SOFTWARE

Step FORTH to RPL

RPL is a FORTH-like language that runs on PET and CBM (Commodore Business Machines) computers. RPL (Reverse Polish Language) uses the Commodore BASIC screen editor for program entry and editing, but does not inhibit the use of BASIC throughout a software development session. The RPL Compiler and the screen-oriented, object-level Symbolic Debugger reside in the top 8K bytes of memory and can be called directly from BASIC commands. Source code is saved to disk or cassette and is compiled memory-to-memory.

RPL has special keywords and symbols that let you nest multiline IF. . . THEN. . .ELSE constructs and FOR. . .NEXT loops. Other special keywords and symbols offer named subroutines and functions of arbitrary length, 16-bit integer arithmetic and logical manipulations, built-in character-string handling, stack-management directives that include n-index and n-rotate, access to machine language, predefined arrays with numeric and string contents, local and global symbols, and forward and backward symbolic references, including GOTO. Also provided are GET, INPUT, and PRINT operators.

The RPL Compiler, including a 60-page user's manual, is available on disk for $49.95 or on cassette for $44.95. The complete Compiler and Symbolic Debugger costs $80.91 on disk or $71.91 on cassette; manuals are available for $10 and $4, respectively. For details, contact Samurai Software, POB 2902, Pompano Beach, FL 33062, (800) 327-8965, ext. 2; in Florida (305) 782-9985.

Circle 555 on inquiry card.

Take Your Projects to Task

Task is a management tool to help you schedule a project. It combines the procedures of PERT (Performance, Evaluation, and Review Techniques) and the Critical Path Method, which divides a complex project into assignments and determines which are critical to the overall completion of the project. Task determines the scheduled start and completion dates for each assignment in a project, which tasks cannot be delayed if the project is to be completed on time, and the amount of time each noncritical task can be delayed without affecting the completion date of a project. Among the options included with Task are the ability to create a calendar to work with a particular work schedule, an expanded Gantt diagram, and a management report that can detail each task, including its start and finish times.

Task is a compiled program running under CP/M. It costs $329 and is available from AMSI, Suite 200, 1935 Cliff Valley Way NE, Atlanta, GA 30329, (404) 634-9535.

Circle 556 on inquiry card.

Overlay Compiler

An overlay structure is now possible with North Star BASIC under an extension to the Comstar compiler. Overlay structures differ from program chaining in that a root program segment and selected program variables remain intact when a new program segment is introduced. Overlay structures permit large programs to be executed.

The Overlay extension is suitable for menu-driven programs and includes a Comstar-CP/M capability. The Overlay extension is available to registered owners of the Comstar compiler for $75 from Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107, (213) 793-5748.

Circle 557 on inquiry card.

Smartkey for CP/M and Software Applications

The Smartkey is a keyboard utility for the CP/M operating system that solves the problem of incompatibility between the console keyboard hardware and applications software. The program acts as an interface between the keyboard and CP/M by allowing the user to "redefine" the keyboard. Codes generated by individual keys can be changed at will or made to generate a sequence of characters at each keystroke. The keyboard's layout can be improved or customized for particular applications software, and sets of key definitions can be saved to disk for later use. Definitions can be altered at any time.

Smartkey does not require hardware or software knowledge to install or use. It's available for $39 from FBN Software, 1111 Sawmill Gulch Rd., Pebble Beach, CA 93953, (408) 373-5303.

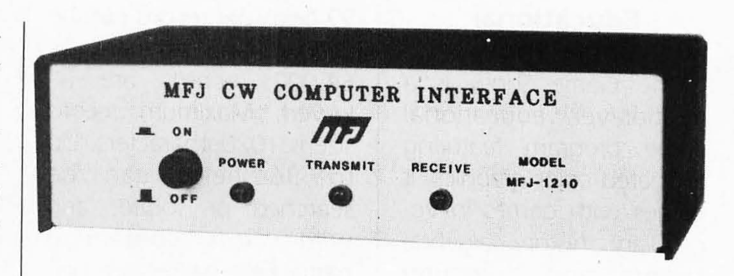
Circle 558 on inquiry card.

Mail-List Manager

The One-Disk Mail-List Manager is a mailing-list management and a label-printing utility for Radio Shack's TRS-80 Models I and III. The program disk can hold 430 records that include name, company, address, and zip code. Records can be sorted alphabetically or by zip code using machine language at a speed of 100 records every 3.5 seconds. Entries are made on a first-name-first basis, and multiple entries are handled by single-keystroke repetition of the address. Labels can be printed from sorted or unsorted lists and by any combination of selection fields. Other features include a label-selecting Print Key that can print labels for any geographic area (i.e., city, state, or zip code).

The One-Disk Mail-List Manager requires 32K bytes of memory; conversion to Model III DOS is necessary. It costs $34.95 and is available from Manhattan Software, POB 1063, Woodland Hills, CA 91365. MasterCard or Visa holders can order by calling (213) 704-8495.

Circle 559 on inquiry card.



Continuous Wave Interface for TRS-80

MFJ Enterprises' CW (continuous wave) Transceive Program and Hardware Interface lets you send CW on your keyboard and receive CW on your video-display screen. It features a tri-split screen for received messages, transmit buffer, and programmable message index. Its text buffer can hold 3295 characters when used with a 16K-byte machine, and it can be preloaded while receiving messages. The package has ten 199-character programmable message memories with on-screen message index. Messages can be repeated or combined, and speed is adjustable from 12 to 55 words per minute (wpm). For group-code practice, up to 2200 characters can be stored. The package automatically receives up to 100 wpm and allows you to store up to five screens of received CW. When the transmit buffer is empty, the mode is automatically changed to receive.

MFJ's hardware interface plugs between the transceiver and the computer without modifications. The cassette-based, disk-compatible program and the hardware-interface package run on a 16K-byte TRS-80 Model I or III. The Transceiver and Hardware Interface costs $99.95, plus a $4 shipping charge. Contact MFJ Enterprises Inc., POB 494, Mississippi State, MS 39762, (601) 323-5869. MasterCard or Visa holders can order by calling (800) 647-1800.

Circle 560 on inquiry card.

Let Your Modem Do the Talking

The automated sales force at Telephone Software Connection delivers its products at any time of the day or night over telephone lines. The Connection's Apple-compatible software comes with complete documentation embedded in the programs. The Connection presently offers telecommunications software, games, and educational programs, as well as utilities for the Apple II. Several free programs are offered by means of the telecommunications hookup.

For more information, contact Telephone Software Connection Inc., POB 6548, Torrance, CA 90504, (213) 516-9430. The telephone number for the modem connection is (213) 516-9432. Payment is by credit card.

Circle 561 on inquiry card.

Educational Game Show

The Game Show is a multiplayer educational game program featuring animated color graphics. It comes with games in vocabulary, history, algebra, sailing, and computer terms. An authoring system that lets you add your own topics is provided.

The Game Show runs on the Apple computer. It costs $45, which includes documentation, a one-year warranty, and a backup disk. Available at computer dealers or directly from Computer-Advanced Ideas Inc., Suite 341, 1442A Walnut St., Berkeley, CA 94709, (415) 526-9100.

Circle 562 on inquiry card.

Profile III+

The Profile III+ is a database management package for Radio Shack's TRS-80 Model III computer. It can communicate with Personal Software's Visicalc financial-modeling program and with Radio Shack's Superscripsit word-processing program. This combination gives the Model III owner a complete management-information tool.

Profile III+ is menu-driven with user options appearing at the bottom of the screen. Customized or special limited menus can be created. The system's screen editor lets database designers visually organize an input screen, and fields and user prompts can be moved by means of function keys. Screens can be password-protected. Up to 99 fields per record can be defined, and as many as 64,000 records are allowed. Maximum record size is 1020 characters. Up to 36 fields can be searched or sorted, and wild cards containing partial-field values are permitted.

Profile III+ requires a 48K-byte TRS-80 Model III with a single disk drive. It costs $300, which includes manufacturer-supplied updates. Contact The Small Computer Company Inc., 40 West Ridgewood Ave., Ridgewood, NJ 07450, (201) 445-5643.

Circle 563 on inquiry card.

Integrate Real-Time Software Tasks

The Multi-Tasking Kernel is a tool for integrating multiple real-time software tasks in 8085-, Z80-, 6502-, 6800-, and 6809-based microcomputer products. The package includes source code for a basic multitasking organization in which tasks self-schedule in a round-robin fashion. The package provides the user with guides through a series of enhancements for carrying out sophisticated, interrupt-initiated, preemptive priority dynamic-task scheduling. Also included are descriptions of dedicated and shared resource scheduling, time-slice scheduling, and intertask communication schemes.

The Multi-Tasking Kernel costs $195, which includes assembly-language source-code implementations for the 8085, Z80, 6502, 6800, and 6809 microprocessors. Contact US Software, 5470 Northwest Innisbrook Pl., Portland, OR 97229, (503) 645-5043.

Circle 564 on inquiry card.

BASIC Editor for TRS-80s

EDIT is a full-screen BASIC editor for Radio Shack's TRS-80 Models I and III. It features a floating-point cursor with automatic repeat functions and a Scripsit-like control structure for easy handling. More than 30 commands permit professional-quality editing of BASIC text at the character, word, line, or block level.

EDIT was developed in England by Southern Software. It costs $40 and is being distributed in the U.S. by Allen Gelder Software, POB 11721, Main Post Office, San Francisco, CA 94101.

Circle 565 on inquiry card.

Insurance Rating Programs

Orion Business Systems' Orionrater programs could make the insurance agent's rating book a piece of the past. This series of property and casualty rating programs can quickly compare and print out quotes. They are simple to operate and do not require insurance or technical backgrounds. Among the programs available are Auto insurance, Homeowners/Condo Owners and Renters insurance, Commercial Truck insurance, and Commercial Liability insurance.

Most Orionrater programs run on 48K-byte Apple II Plus computers equipped with a disk drive and controller, a monitor, and a printer. Prices range from $475 to $750. For complete specifications, contact Orion Business Systems, Suite 102, 11777 Bernardo Plaza Court, San Diego, CA 92128, (714) 485-8580.

Circle 568 on inquiry card.

C/80 Compiler

C/80 is a compiler for the C programming language that provides random-access file I/O (input/output) and Macro-80 compatibility. It generates 8080 assembly-language code for the assembler or for Microsoft's Macro-80 relocatable assembler and linking loader. All C language control statements and arithmetic and logical operators are supported as well as character and 16-bit integer data, pointers, arrays, strings, data initialization, inline assembly language, conditional compilation, and most preprocessor functions. C/80's run-time library provides standard C I/O functions and features dynamic storage allocation, I/O redirection, and a run-time execution-profile facility for easy program optimization.

C/80 lacks structures, pointers to pointers, and long and floating data types. Available on 8-inch CP/M disks and on 5¼-inch Heath/Zenith CP/M or HDOS disks, C/80 costs $39.95. Contact The Software Toolworks,

14478 Glorietta Dr., Sherman Oaks, CA 91423, (213) 986-4885.
Circle 569 on inquiry card.

Atari Graphics Composer

The Graphics Composer is a joystick/paddle graphics software package for Atari 400/800 microcomputers. With it you can draw the outline of a picture in high-resolution screen mode 8 or 7 using a joystick or paddle; then you can use color fill-in, color brushes, and text to complete your graphics scheme. The graphics can then be saved to disk or cassette.

Graphics Composer is supplied with a Geometric Figures program that allows you to define circles, triangles, polygons, parallelograms, and trigonometric curves. Graphics Composer is available in both cassette and disk versions for $39.95. It requires 32K bytes of programmable memory. Contact Versa Computing Inc., Suite 104, 3541 Old Conejo Rd., Newbury Park, CA 91320, (805) 498-1956.
Circle 570 on inquiry card.

New C Compiler

Phase One Systems has unveiled a C compiler for its Oasis operating system. Oasis C supports most Unix Version Seven C features. It produces Z80 assembler code and is provided with an optimizer that reduces compiled code between 30 and 50%. Among the attributes of Oasis C are pointers, structures, assignment operators, a full I/O (input/output) library, and compile options. A version of Oasis C for the 16-bit-compatible Oasis-16 will be available.

Oasis C costs $250. For complete details, contact Phase One Systems Inc., Suite 830, 7700 Edgewater Dr., Oakland, CA 94621, (415) 562-8085.
Circle 571 on inquiry card.

PERIPHERALS

Model III Cash-Register Expansion System

The CR-180 is a cash register/point-of-sale expansion system for the TRS-80 Model III microcomputer. It stores transactions for up to 100 employees, saves eight methods of payments, and provides inventory control and complete reporting. The CR-180 can produce daily sales and cash reports by employee and by type of transaction, inventory usage reports, and gross profit computation. Also, price and shelf labels can be printed.

The CR-180 expansion system is supplied with an electronic cash drawer and a receipt printer which plug directly into the TRS-80 Model III. Audio has been added for keystroke confirmation. Prices range from $900 to $1900. Contact Integrated Cash Register/Futuresoft, Southern Region, Suite 203, 2301 Park Ave., POB 1446, Orange Park, FL 32073, (904) 269-1918.
Circle 572 on inquiry card.



Draft- and Letter-Quality Printer

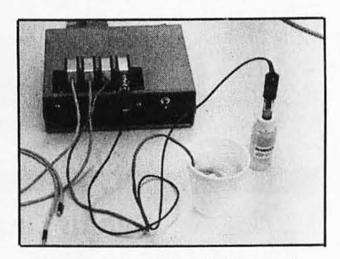
Printer Systems' Model 1800 printer can produce both correspondence- and draft-quality printouts. It is plug-compatible with IBM Series I or System 34/38 computers as well as Univac, Burroughs, Honeywell, DEC (Digital Equipment Corp.), and Data General computers. In the draft mode, the Model 1800 prints at 200 cps (characters per second) with a 7 by 9 dot-matrix format. In the correspondence mode, it prints at 50 cps in a 40 by 18 format. The Model 1800 features a forms-length selector switch and quiet operation.

The Model 1800 printer is available for $2695 from Printer Systems Corp., Suite 104, 1 West Deer Park Rd., Gaithersburg, MD 20760, (301) 840-1070.
Circle 573 on inquiry card.

I/O Control Card

The G519I/O card is an interface between the Multibus and Gordos industry-standard PB-16/PB-24 I/O (input/output) module boards. The card can control up to 72 AC or DC input or output modules in any combination or position on the I/O module board. It can also serve as a general-purpose TTL (transistor-transistor logic) interface card for control of up to 72 bidirectional I/O lines.

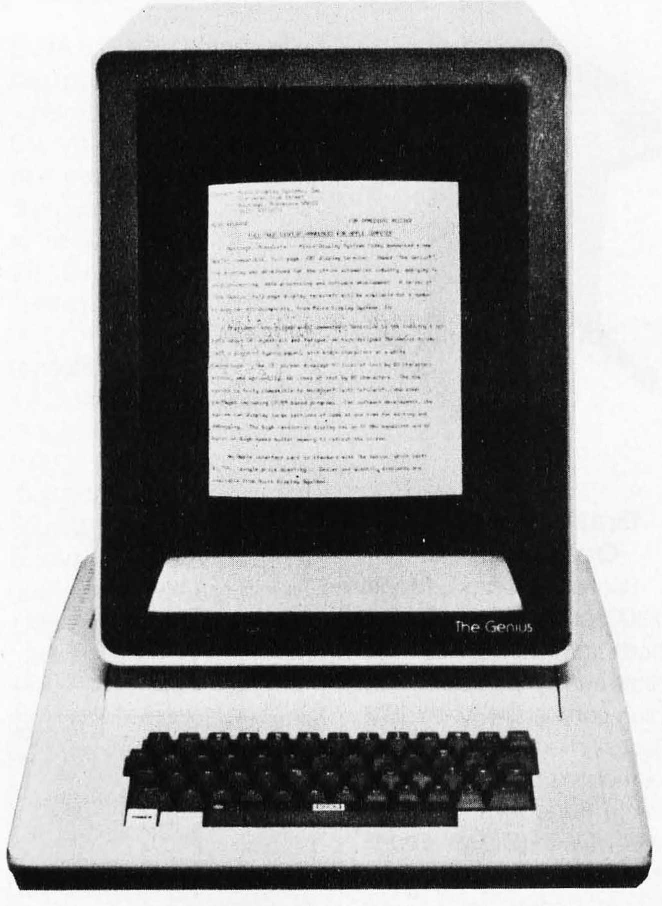
Gordos International also has interface cards for the RM-65, the Exorcisor II, and STD bus. The G519 I/O card is priced at $500. For details, contact Gordos Corp., 250 Glenwood Ave., POB 100, Bloomfield, NJ 07003, (201) 743-6800.
Circle 574 on inquiry card.



Analog Peripheral

The Analog Peripheral is a self-contained 8-bit A/D (analog-to-digital) converter that can connect to any computer. It has a switch-selectable RS-232C output line with data transmission rates from 110 to 9600 bps (bits per second). Other features include a 26-pin parallel output, four input channels, conversion speeds of 100 microseconds, power supply, and plug-in sensors for temperature, light and other analog signals. For complete details on the Analog Peripheral, contact Cambridge Development Laboratory, 36 Pleasant St., Watertown, MA 02172, (617) 926-0869.
Circle 575 on inquiry card.

What's New?



Genius Display System

The Genius is an Apple-compatible, full-page video-display terminal. The 15-inch Genius displays 57 lines of text by 80 characters, or optionally 66 lines by 80 characters. The Genius is compatible with the Wordstar word-processing system and many CP/M-based programs. Large sections of code can be displayed at one time, which is a plus for software developers, and the high-resolution display has an 87 MHz bandwidth and 6K bytes of high-speed buffer memory.

The Genius is supplied with an Apple interface card. It is available for $1795 from Micro Display Systems Inc., 514 Vermillion St., Hastings, MN 55033, (612) 437-2233.

Circle 576 on inquiry card.

Single-Pen Drum Plotter

The Complot CPS-20 is a single-pen, 11-inch drum plotter that can interface with most computers. The only alteration needed to use the CPS-20 with different computers is the switching of a single interface card. The high-efficiency CPS-20 operates at 3 inches per second at a resolution of 0.005 inch. It costs $3995. Contact Houston Instrument, One Houston Square, Austin, TX 78753, (512) 837-2820.

Circle 577 on inquiry card.

Line Controller Adds Voice Synthesis

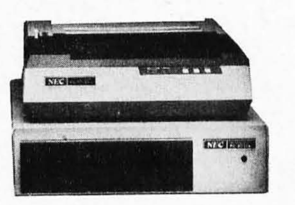
The SLC-II is a serial line controller that combines microprocessor intelligence with a versatile voice-synthesis capability. The controller can automatically dial telephone lines and talk by means of its electronically synthesized voice. It can listen and respond to incoming messages that originate at a remote terminal or are generated by a telephone keypad. The SLC-II's vocabulary includes more than 300 words as well as the complete alphabet and numerals, and it will spell any word it cannot say.

The SLC-II provides ASCII input/output, Touch-Tone input, printer output, external amplifier output, and synthesized voice output. A built-in power backup is provided by rechargeable batteries. In addition, the SLC-II features an auto-dial/auto-answer modem; 16K, 32K, or 80K bytes of programmable memory; and automatic time and date entry with day, month, and year. Applications include data collection and transmission, telephone access to large databases, alarm signaling, and security or facility monitoring. Connections to existing computer systems are made by standard RS-232C or 20 mA serial-loop interface.

In single-unit quantity, the SLC-II costs $1975. Contact Digital Pathways Inc., 1260 L'Avenida, Mountain View, CA 94043, (415) 969-7600.

Circle 578 on inquiry card.





Dot-Matrix Printer

NEC Home Electronics' PC-8023A dot-matrix printer can bidirectionally print the upper- and lowercase ASCII (American Standard Code for Information Interchange) character set featured on the PC-8001A microcomputer. In addition, the printer provides many Greek, mathematical, and graphics symbols. The high-speed PC-8023A is equipped with a standard parallel interface and features the ability to print dot-graphics screens on paper. Up to three copies of fanfold, roll, or cut-sheet paper and originals are possible using either pin- or friction-feed delivery. Paper widths range from 11.5 to 25 cm (4½ to 10 inches).

The PC-8023A's matrix options include 7 by 9 English or 8 by 8 graphic and dot graphic, ranging from 40 columns by 4 characters per inch to 136 columns by 17 characters per inch. Print speed is 100 cps (characters per second), and all fonts fea-

ture fixed- or proportional-spacing format options at 6 or 8 lines per inch, plus 1/144-inch incremental line feed.

The PC-8023A printer costs $795. Contact NEC Home Electronics USA, Personal Computer Division, 1401 Estes Ave., Elk Grove Village, IL 60007, (312) 228-5900.

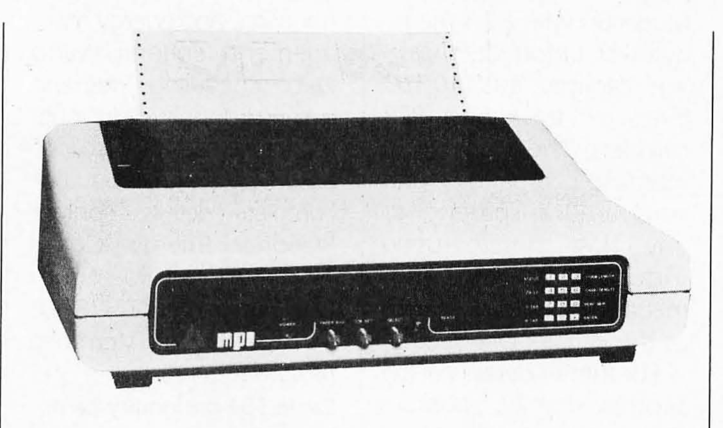
Circle 579 on inquiry card.

Apple II ROM Board

The Andromeda ROM (read-only memory) Board lets you plug utility programs into your Apple II and access them without loading from disk. The Board has space for 2K- or 4K-byte PROMs (programmable read-only memories) and it can accommodate 2K-byte programmable memory devices. (This gives you read/write capabilities for developing custom PROM programs.) Two 2732 PROMs allow a total of 8K bytes of memory on the ROM Board.

The ROM Board is supplied with a utility ROM that gives you five options with your Applesoft programs: you can perform automatic line numbering, alphabetize a disk catalog, control a program list with a page mode, restore crashed Applesoft programs in memory, and create a disk without using the disk operating system. The ROM Board with utility ROM costs $125 and is distributed by Computer Data Services, POB 696, Amherst, NH 03031, (603) 673-7375.

Circle 580 on inquiry card.



Heavy-Duty Printer

The Model MP150 matrix printer has a heavy-duty print head, rated for continuous duty, with an expected life in excess of 100 million characters. Characters are formed bidirectionally in a logic-seeking mode to optimize system throughput. Nine print wires provide clear characters with true descenders and underscores. The MP150 can print 136 characters per line at 10 characters per inch, or up to 226 columns can be printed by selecting the 12- or 16.7-character-per-inch density. Double-width characters are software-selectable. A 7 by 9 matrix font is used for high-speed data printing and an 11 by 9 serif-style matrix font can be used for high-quality printouts. The MP150 features the standard 96-character ASCII (American Standard Code for Information Interchange) set with four strap-selectable foreign fonts.

The MP150 is capable of high-resolution dot-addressable graphics for plotting, printing of screen graphics, and drawing of illustrations. Forms handling is carried out by a stepper-motor-drive tractor paper feed that can be adjusted to accept forms from 7.5 to 38 centimeters (3 to 15 inches) in width. Eight user-selectable forms lengths, skip-over-perforation, and six user-selectable character densities are featured.

The MP150's 1K-byte buffer is expandable to 8K bytes, and its Centronics-type interface can accept parallel TTL (transistor-transistor logic) level data at over 1000 characters per second. Optionally, an RS-232C serial interface can be added to the MP150. The RS-232C interface can accept data at any one of seven rates up to 9600 bps (bits per second) and it supports X-ON/X-OFF and ETX/STX protocols. Another option is an IEEE-to-Centronics interface adapter card for connecting devices with an IEEE-488-bus output port.

The Model MP150 printer costs $1095. Contact MPI, 4426 South Century Dr., Salt Lake City, UT 84107, (801) 263-3081.

Circle 581 on inquiry card.

Universal Systems Interface

The Shugart Associates Systems Interface (SASI) is a universal interface that allows streaming-tape cartridge and floppy- and Winchester-disk drives to use a standard system interface. SASI eliminates having to develop new controllers, host adapters, and software drivers each time a new memory device is integrated into a system. Other SASI operating features include the ability to attach up to eight host processors and controllers per SASI bus, a search capability to assist file-management systems in locating key parameters, multiple command types, and self-arbitration for control of the SASI bus on a memory-device-priority basis.

SASI is already available on Shugart's SA1400 Series of disk-drive controllers.

In OEM (original equipment manufacturer) quantities, the price for Shugart's SA1400 series of disk-drive controllers with an SASI interface begins at $565. For complete details, contact Shugart Associates, 475 Oakmead Parkway, Sunnyvale, CA 94086, (408) 733-0100.

Circle 582 on inquiry card.

Scorpio Family

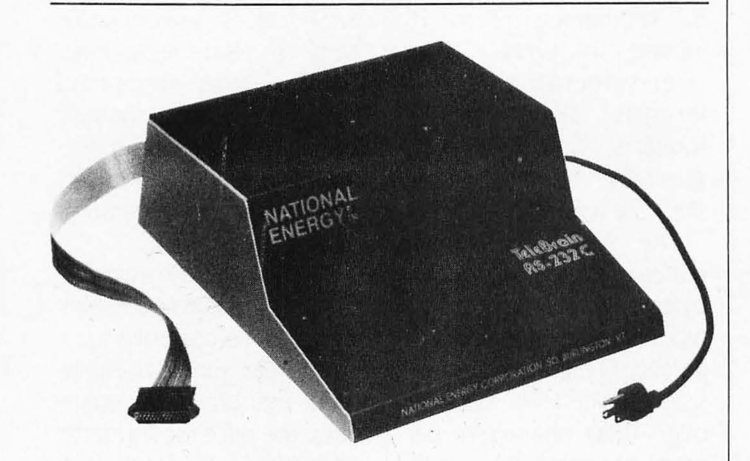
The Scorpio family of 8-inch Winchester disk drives from Ampex have an average access time of 30 milliseconds with a data-transfer rate of 1.2 megabytes and an average latency of 8.3 milliseconds. This is achieved by means

of a linear voice-coil actuator in a closed-loop servo system. All critical components are enclosed in a sealed module to assure long-term reliability and data integrity. Additional features ensuring data integrity include head-landing zones, module shock mounting, and self-actuating head-carriage and disk-spindle locks. Mean time between failures is 10,000 hours.

The Scorpio family is available in two versions: Model 48 with 49.7 megabytes of storage and the Model 80 with 82.9 megabytes of unformatted storage capacity and 20,160 bytes per track over 823 cylinders. The Model 80 is interface-compatible and software-transparent to any host system using industry-standard 80-megabyte disk drives, such as the Ampex DM-980.

For further details on the Scorpio family, contact Ampex Corporation, Memory Products Division, 200 North Nash St., El Segundo, CA 90245, (213) 640-0150.

Circle 583 on inquiry card.



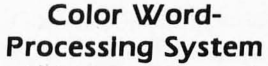
Wireless Building Automation

The Telebrain RS-232C is a wireless computer interface that can communicate programmed, automated-switching decisions throughout an entire facility using the existing AC wiring. It can transmit switching decisions emanating from a host computer, per software developed by the facility, to any one of 1600 independent-control points, or Teleswitches. The Teleswitch recieves and identifies the command and performs the necessary switching.

Telebrain incorporates National Energy's Solution 100 and Solution 1600 programs and the Telegain amplifier. The Solution 100 software includes independent programmable control of up to 83 unique points allowing for 7-day programming, daily start-up, shut-down, and duty cycling. Telebrain can interface with any computer that has an RS-232C serial output port.

Applications include facility management and automation including lighting control, activation of security systems, materials handling, and energy management encompassing load scheduling, demand limiting, duty cycling, optimum start-up, and so on, based on analog input. For complete details, contact National Energy Corp., 1795 Williston Rd., South Burlington, VT (800) 451-3410; in Vermont (802) 658-6445.

Circle 584 on inquiry card.



Color Word-Processing System

NEC Home Electronics' color word-processing system features a self-teaching program and a 12,000-word dictionary. The system is menu-driven, which reduces the possibility for errors, and features all-green text, instructions in yellow or blue, and violet-highlighted potential deletions. The system provides automatic page numbering, draft printing without leaving the document, stock-paragraph and form-letter appending to any document, automatic disk-overflow routine, user-oriented document name listing, unlimited headers and footers, disk-supply indicator, single-key commands, and block move, copy, delete, write, print, and justification capabilities.

When combined with NEC's PC-8001A microcomputer, color monitor, printer, I/O (input/output) unit, and a disk drive, the color word-processing system adds the final touch to a complete computer system that costs less than $6000. Contact NEC Home Electronics USA, Personal Computer Div., 1401 Estes Ave., Elk Grove Village, IL 60007, (312) 228-5900, for complete details.

Circle 585 on inquiry card.

Portable Terminal Has Modem and Printer

Business people will find the Lex-21 portable printing and communications terminal useful in providing access to remote computing services, in field service, for inventory checks, accounting systems, electronic mail, and up-to-the-minute price quotations. Lex-21 features a 59-key ASCII (American Standard Code for Information Interchange) keyboard and a 40-column thermal printer with upper- and lowercase descenders and a 5 by 7 dot-matrix character format. It has a built-in full-duplex 300 bps (bits per second) modem with originate or answer modes, Bell 103A compatibility, and an FCC-approved handset connection. Its industry-compatible asynchronous communications protocol allows transmission at 10 or 30 characters. Its battery-backed memory includes a 1K-byte receive buffer and 2K bytes of compose and edit memory.

The Lex-21 costs $1195. For details, contact Lexicon Corporation, 1541 Northwest 65th Ave., Fort Lauderdale, FL 33313, (305) 792-4400.

Circle 586 on inquiry card.

What's New?



Video Selector

The Archer Video Selector is a compact, push-button video-switching and control center designed to eliminate the need to repeatedly change cable connections. It simplifies signal routing even for complex home video systems. Two banks of push buttons provide the necessary switching and signal routing between four 75-ohm coaxial inputs and one phono jack to three 75-ohm coaxial outputs. The inputs permit the connection of any combination of five video sources, such as cable television, an antenna, a videocassette or videodisc player, a camera, and a small computer. The three outputs allow simultaneous viewing and recording of a selected input.

The Archer Video Selector offers a signal-path bandwidth from 50 to 900 MHz. No power is required. The Archer Video Selector costs $79.95 and is available at Radio Shack stores and participating dealers. Contact Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3300.

Circle 587 on inquiry card.

ROM Simulator

Lamar Instruments' ROM (read-only memory) simulator is designed to reside in an Apple II-based development system for use in developing software for another, "target" computer. The device can take the place of a ROM, PROM (programmable ROM), or EPROM (erasable programmable ROM) normally located in the target computer and is useful for developing software eventually destined to be placed in ROM. The ROM simulator connects to the target computer by means of a 24-pin dual-inline package (DIP) and a ribbon cable.

The double-sided ROM simulator has plated-through holes, silk-screened legends, gold-plated contact fingers, and is solder-masked. It has 2K bytes of high-speed, low-power, CMOS (complementary metal-oxide semiconductor) static programmable memory that resides in hexadecimal C800 to CFFF in the Apple II memory map. It contains the necessary logic to automatically switch control of the address and data bus from the Apple II to Lamar Instruments' Superkim (i.e., target) ROM sockets. The price is $295. Contact Lamar Instruments, 2107 Artesia Blvd., Redondo Beach, CA 90278, (213) 374-1673.

Circle 588 on inquiry card.

Options Package for DS180 Printer

Datasouth Computer's special package of options for its DS180 matrix printer includes graphics, compressed print, display mode, an expanded buffer, and a dot-addressable raster-scan feature that lets you print computer-generated charts and graphics. Under program control, six print wires can be addressed to print high-density output at a resolution of 75 by 72 dots per inch.

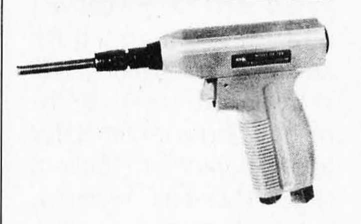
In the compressed print mode, the package permits manual or program selection of print sizes including 10, 12, and 16.5 characters per inch as well as expanded modes of 5, 6, and 8.25 characters per inch. This permits the DS180 to print from 132 columns on an 8½-inch form to 217 columns on a 14⅞-inch form.

The display mode lets you print out or "display" the nonprinting ASCII (American Standard Code for Information Interchange) control codes.

The package of options costs $150. The DS180 printer, which operates at 180 characters per second, costs $595. Contact Datasouth Computer Corp., 4740-A Dwight Evans Rd., Charlotte, NC 28210, (704) 523-8500.

Circle 589 on inquiry card.

MISCELLANEOUS



Wire-Wrap Tool

The Model OK-729 pneumatic wire-wrapping tools feature precision steel drive components enclosed in a Lexan-reinforced case. A positive indexing mechanism with adjustable stop location and a 6-foot (2-meter) flexible air hose are provided. The OK-729 is available in two versions: a 5000 RPM (revolutions per minute) version and a model with a higher torque and a speed of 3000 RPMs for cut/strip/wrap applications. Both versions are designed to operate at 80 to 100 pounds per square inch and are fully rated for heavy-duty applications on wire as large as 18 AWG (American Wire Guage) or for more delicate work on wire as small as 30-32 AWG.

The OK-729 wire-wrap tool is available for $188.57. Contact OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475, (212) 994-6600.

Circle 590 on inquiry card.

New EEPROM

The ER5716 EEPROM (electrically erasable programmable read-only memory) is the newest member of General Instrument Microelectronics' line

of electrically alterable nonvolatile memories. It's based on N- (negative-) channel silicon-gate MNOS (metal-nitride-oxide semiconductor) technology and is designed for applications that require a large (16K-bit) memory, such as microprocessor-program storage, where nonvolatility is essential but occasional data changes must be made. The ER5716 features improved access time and infinite read capabilities. It is bulk-erasable and can be electrically reprogrammed.

The ER5716 EEPROM is available in single units at General Instrument dealers. In OEM (original equipment manufacturer) quantities, it costs $35.70. Contact General Instrument Corp., Microelectronics Div., 600 West John St., Hicksville, NY 11802, (516) 733-3107, for additional information.

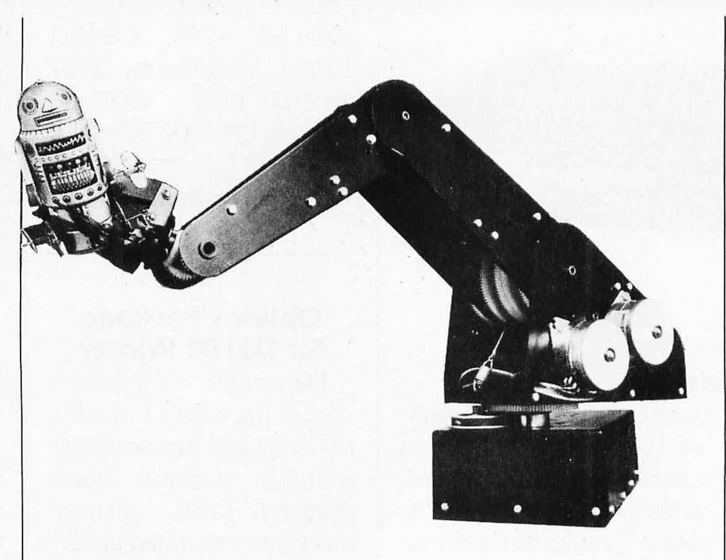
Circle 591 on inquiry card.

Cope with Scopes

The XYZs of Using a Scope will not only show you how an oscilloscope works, but how to make one work for you. Divided into two sections, the primer first covers the nuts and bolts and oscilloscope control functions, then expands to demonstrate waveforms, waveshapes, and measurement techniques.

The XYZs of Using a Scope is available free from Tektronix Inc., POB 4828, Portland, OR 97208, (800) 547-6711; in Oregon (800) 452-6773.

Circle 592 on inquiry card.



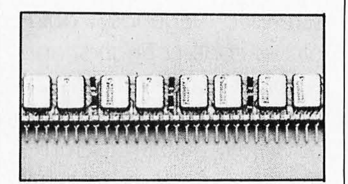
Robotics Arm for Education and Hobby

Colne Robotics of England recently introduced the Armdroid I, an educational and hobbyist manipulating arm. The arm has five axes of rotation (base, shoulder, elbow, wrist up and down, and wrist rotate), a three-finger gripper, and is completely stepper-motor-driven. The Armdroid I will operate with any microcomputer, requiring only a latched 8-bit parallel port to interface. The arm has a 17-inch reach, can lift 10 ounces, has a gripping force of 5 pounds and a resolution of 0.15 inch.

Colne Robotics intends to produce a newsletter for owners of the arm, as well as introduce new products to enhance the arm, such as tactile sensors for closed-loop operations. The Armdroid I can be easily modified to accept experimental devices such as alternate gripper devices, tactile sensors, micro switches, and potentiometers.

The Armdroid I is available in kit form for $595 and includes Z80 machine-language driver software for the TRS-80 Model I and the power/interface board kit. An assembled version is also available for $695. For further information, contact Colne Robotics Inc., 207 Northeast 33rd St., Ft. Lauderdale, FL 33334 or Colne Robotics Co. Ltd., 1 Station Rd., Twickenham, Middlesex TW1 4LL, England, 1-892-7044; Telex: 8814066 GCIC.

Circle 593 on inquiry card.



High-Density Memory Requires Less Space

Electronic Designs' EDH-4816 is a 128K-byte high-density memory that requires only one fifth the area of an equivalent DIP (dual inline package). The EDH-4816 consists of eight industry-standard 16K by 1-bit random-access read/write memories in carriers mounted on a 32-pin SIP (single inline package). The EDH-4816 has all standard operating modes. Access time is 200 ns (nanoseconds); cycle time is 375 ns.

In single-unit quantities, the EDH-4816 costs $68. In 100-unit quantities, the price is $59. Contact Electronic Designs Inc., 230 Eliot St., Ashland, MA 01721, (617) 881-5244.

Circle 594 on inquiry card.

TRS-80 Network

Radio Shack will use ARCNET to provide a low-cost, high-speed local network for the TRS-80 Model II microcomputer. ARCNET is the local network component of Datapoint's ARC (Attached Resource Computer) system. ARCNET provides an inexpensive, efficient means to link a large number of computers together. Each computer in the ARCNET can access common databases, such as accounting, word-processing information or electronic filing systems, and share peripherals (printers, for example) throughout the network. In addition to Datapoint's new LSI integrated-circuit network interface, Radio Shack will use ARCNET protocols and software for cost-effective, high-speed common-resource networking. The ARCNET will permit as many as 255 Model IIs and their peripherals to be interconnected.

Datapoint processors and peripherals, such as its

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Product Family	Product Description	Memorex Part Number (3201-)	CE quant. 100 price per disc ($)	Athana	BASF	Dysan	IBM	Maxell	Nashua	Scotch 3M	Shugart	Syncom	Verbatim	Wabash	Control Data
Flexible Disc 1s	IBM Compatible (128 B/S, 26 Sectors)	3060	1.99	473071	53428	800506	2305830	FD1-128	FD-1	740-0	S/A 100	15002	FD34-9000	F111111X	421602
Single-Headed Drives	IBM Compatible (128 B/S, 26 Sectors) w/ W.P.N	3062	2.04	–	–	–	–	–	–	740-0	–	–	FD34-9000	–	–
Single-Density Media	IBM Compatible (128 B/S, 26 Sectors) w/ W.P.N. & Hub Ring	3064	2.39	–	–	–	–	–	–	–	–	–	FD34-9000	–	–
	IBM Compatible (128 B/S, 26 Sectors) REVERSIBLE	1729	3.19	473072	54431	–	–	–	FD-2	740/2-0	–	15150	FF34-9000	F171111X	–
	IBM System 6 Compatible	3066	2.04	473077	54561	800509	1669959	–	–	740-0 DS6	–	15003	FD60-9000	F116111X	–
	IBM Compatible (256 B/S 15 Sectors)	3109	1.99	473073	–	800584	2305845	–	–	740-3600	–	15005	FD36-9000	F112111X	–
	IBM Compatible (512 B/S 8 Sectors)	3110	1.99	473074	–	800585	1669954	–	–	–	–	15004	FD60-9000	F113111X	–
	Shugart Compatible, 32 Hard Sector	3015	1.99	470901	53802	101/1	–	FH1-32	FD-132	740-32	S/A-101	15025	FD32-9000	–	421322
	Wang Compatible, 32 Hard Sector w/Hub Ring	3087	2.49	–	54491	–	–	–	–	740-32RH	–	–	–	F37A411X	–
	CPT 8000 Compatible	3045	2.69	–	–	–	–	–	–	–	–	15226	–	–	–
Flexible Disc 1d	IBM Compatible (128 B/S 26 Sectors)	3090	2.69	474071	54568	3740/1D	–	FD1-128/M2100	FD-1D	741-0	–	–	FD34-8000	F131111X	423002
Single-Headed Drives	Soft Sector (128 B/S, 26 Sectors) REVERSIBLE	3093	3.69	–	–	–	–	–	–	–	–	–	–	–	–
Double-Density Media	Shugart Compatible, 32 Hard Sector	3091	2.69	470801	54596	101/1D	–	FH1-32D	–	741-32	S/A-103	15075	FD32-8000	F33A411X	423322
	Wang Compatible, 32 Hard Sector w/Hub Ring	3088	3.09	–	–	–	–	–	–	–	–	–	–	–	–
Flexible Disc 2s	Soft Sector (128 B/S, 26 Sectors)	3113	3.09	–	54428	800814	1766870	–	–	–	S/A-150	15153	FD10-4026	F121111X	–
Double-Headed Drives	Soft Sector (256 B/S, 15 Sectors)	3106	3.09	473477	54226	800815	2736700	FD2-256D	–	742-0	–	15154	FD10-4015	F122111X	424612
Single-Density Media															
Flexible Disc 2d	Soft Sector (Unformatted)	3102	3.09	473485	–	DY150	–	FD2-XDM	FD-2D	743-0	–	15103	DD34-4001	–	425002
Double-Headed Drives	Soft Sector (128 B/S, 26 Sectors)	3115	3.09	–	–	–	–	–	–	–	S/A-150	–	–	–	–
Double-Density Media	Soft Sector (256 B/S, 26 Sectors)	3103	3.09	473471	54325	800817	1766872	FD2-256D	–	743-0/256	–	15101	DD34-4026	F144111X	425602
	Soft Sector (512 B/S, 15 Sectors)	3114	3.09	473472	54479	800818	1669044	–	–	743-0/512	–	15100	DD34-4015	F145111X	425612
	Soft Sector (1024 B/S, 8 Sectors)	3104	3.09	473473	54485	800819	1669045	–	–	743-0/1024	–	15102	DD34-4008	F147111X	425622
	32 Hard Sector	3105	3.09	470851	–	101/2D	–	FH2-32D	–	743-32	S/A-151	15125	DD32-4000	F34A411X	425322
	Burroughs B-80 Compatible, 32 Hard Sector	3092	3.09	–	–	–	–	–	–	–	–	–	–	F34A611X	–
	Soft Sector (1024 B/S, 8 Sectors) w/ Hub Ring	3116	3.49	–	–	–	–	–	–	–	–	–	–	–	–
	Shugart Compatible, 32 Hard Sector	3181	3.39	–	–	–	–	–	–	–	–	–	DD32-4000	–	–
Flexible Disc FD Memorex 651 or Equiv. Drive Compatible	FD VI (Vinyl Jacket)	30712003	2.69	470651	–	FDIV	–	–	FD-165	511-0	–	15026	FD65-1000	F61A111X	–
Mini Flexible Disc 1s	Soft Sector (Unformatted)	3401	1.94	475001	54256	104/1	–	MD1	MD 1	744-0	S/A-104	15300	MD525-01	M11A211X	441002
5¼" Single-Headed Drives	10 Hard Sector	3403	1.94	475010	54257	107/1	–	–	MD 110	744-10	S/A-107	15325	MD525-10	M41A211X	441102
Single-Density Media	16 Hard Sector	3405	1.94	475016	54258	105/1	–	MH1	MD 116	744-16	S/A-105	15326	MD525-16	M51A211X	441162
	Soft Sector (Unformatted) w/Hub Ring	3431	2.14	–	–	–	–	–	–	–	–	–	MD525-01	–	–
	10 Hard Sector, w/Hub Ring	3433	2.14	–	–	–	–	–	–	–	–	–	MD525-10	–	–
	16 Hard Sector, w/Hub Ring	3435	2.14	–	–	–	–	–	–	–	–	–	MD525-16	–	–
Mini Flexible Disc 1d	Soft Sector (Unformatted)	3417	2.14	–	54646	104/1D	–	–	–	–	–	–	MD525-01	–	–
5¼" Single-Headed Drives	10 Hard Sector	3418	2.14	–	54649	107/1D	–	–	–	–	–	–	MD525-10	–	–
Double-Density Media	16 Hard Sector	3419	2.14	–	54652	105/1D	–	–	–	–	–	–	MD525-16	–	–
	Soft Sector (Unformatted) w/Hub Ring	3481	2.34	–	–	–	–	–	–	–	–	–	MD525-01	–	–
	10 Hard Sector w/Hub Ring	3483	2.34	–	–	–	–	–	–	–	–	–	MD525-10	–	–
	16 Hard Sector w/Hub Ring	3485	2.34	–	–	–	–	–	–	–	–	–	MD525-16	–	–
Mini Flexible Disc 2d	Soft Sector (Unformatted)	3421	2.59	–	54624	104/2D	–	–	–	–	S/A-154	–	MD550-01	–	–
5¼" Double-Headed Drives	10 Hard Sector	3423	2.59	–	54627	107/2D	–	–	–	–	S/A-157	–	MD550-10	–	–
Double Density Media	16 Hard Sector	3425	2.59	–	54630	105/2D	–	–	–	–	S/A-155	–	MD550-16	–	–
	Soft Sector (Unformatted) w/Hub Ring	3491	2.79	–	–	–	–	–	–	–	–	–	MD550-01	–	–
	10 Hard Sector w/Hub Ring	3493	2.79	–	–	–	–	–	–	–	–	–	MD550-10	–	–
	16 Hard Sector w/Hub Ring	3495	2.79	–	–	–	–	–	–	–	–	–	MD550-16	–	–

Memorex Flexible Discs...The Ultimate in Memory Excellence

Quality
Memorex means quality products that you can depend on. Quality control at Memorex means starting with the best materials available. Continual surveillance throughout the entire manufacturing process. The benefit of Memorex's years of experience in magnetic media production, resulting, for instance, in proprietary coating formulations. The most sophisticated testing procedures you'll find anywhere in the business.

100 Percent Error Free
Each and every Memorex Flexible Disc is certified to be 100 percent error free. *Each* track of *each* flexible disc is tested, individually, to Memorex's stringent standards of excellence. They test signal amplitude, resolution, low-pass modulation, overwrite, missing pulse error and extra pulse error. They are torque-tested, and competitively tested on drives available from almost every major drive manufacturer in the industry including drives that Memorex manufactures. Rigid quality audits are built into every step of the manufacturing process and stringent testing result in a standard of excellence that assures you, our customer, of a quality product designed for increased data reliability and consistent top performance.

Customer-Oriented Packaging
Memorex's commitment to excellence does not stop with a quality product. They are proud of their flexible discs and they package them with pride. Both their packaging and their labeling have been designed with your ease of identification and use in mind. The desk-top box containing ten discs is convenient for filing and storage. Both box labels and jacket labels provide full information on compatibility, density, sectoring, and record length. Envelopes with multi-language care and handling instructions and color-coded removable labels are included. A write-protect feature is available to provide data security.

Full One Year Warranty — Your Assurance of Quality
Memorex Flexible Discs will be replaced by Memorex if they are found to be defective in materials or workmanship within one year of the date of purchase. Other than replacement, Memorex will not be responsible for any damages or losses (including consequential damages) caused by the use of Memorex Flexible Discs.

Quantity Discounts Available
Memorex Flexible Discs are packed 10 discs to a carton and 10 cartons to a case. Please order only in increments of 100 units for quantity 100 pricing. We are also willing to accommodate your smaller orders. Quantities less than 100 units are available in increments of 10 units at a 10% surcharge. **Quantity discounts** are also available. Order 500 or more discs at the same time and deduct 1%; 1,000 or more saves you 2%; 2,000 or more saves you 3%; 5,000 or more saves you 4%; 10,000 or more saves you 5%; 25,000 or more saves you 6%; 50,000 or more saves you 7% and 100,000 or more discs earns you an 8% discount off our super low quantity 100 price. Almost all Memorex Flexible Discs are immediately available from **CE**. Our warehouse facilities are equipped to help us get you the quality product you need, when you need it. If you need further assistance to find the flexible disc that's right for you, call the Memorex compatibility hotline. Dial 800-538-8080 and ask for the *flexible disc hotline* extension 0997. In California dial 800-672-3525 extension 0997.

Buy with Confidence
To get the fastest delivery from **CE** of your Memorex Flexible Discs, send or phone your order directly to our Computer Products Division. Be sure to calculate your price using the **CE** prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability, acceptance and verification. All sales are final. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless **CE** is instructed differently. Minimum order $50.00. International orders are invited with a $20.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

Mail orders to: **Communications Electronics**, Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $8.00 per case or partial-case of 100 8-inch discs or $6.00 per case of 100 5¼-inch mini-discs for U.P.S. *ground* shipping and handling in the continental U.S.A. If you have a Master Card or Visa card, you may call anytime and place a credit card order. **Order toll-free** in the United States. Call anytime 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited**. All order lines at **Communications Electronics** are staffed 24 hours.

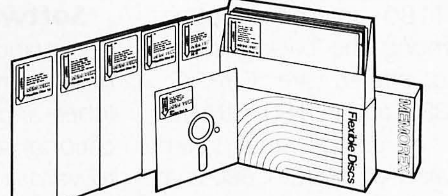








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Circle 84 on inquiry card.

137-megabyte disk memory and 900-line-per-minute printers, will be compatible with the TRS-80 ARCNET. Also, Radio Shack's bisynchronous communications software packages for the Model II will permit certain IBM and DEC (Digital Equipment Corporation) and other mainframe equipment to link with ARCNET.

Each computer in the TRS-80 ARCNET requires an interface card that installs in an existing card slot on the TRS-80 Model II. The card will be made by Texas Peripherals and will sell for approximately $400. Other required components are a coaxial cable and a junction box. For further information, contact Tandy Corporation, 1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3300.
Circle 595 on inquiry card.

Formatted Languages for the VT180

Digital Research has made available formatted language packages for DEC's (Digital Equipment Corporation's) CP/M-based VT180 microcomputer. Among the packages being offered are CBASIC, CB80, and PL/I-80. CBASIC is a compiler-interpreter dialect of BASIC. CB80 is a fast-executing compiler version of CBASIC that provides full support for MP/M. PL/I-80 is an implementation of subset G of the PL/I programming language. These products are available at Digital Research dealers or directly from Digital Research, 130 Central Ave., Pacific Grove, CA 93950, (408) 649-3896.
Circle 596 on inquiry card.

PUBLICATIONS

Planning Guide for Educators

A Planning Guide to Successful Computer Instruction is an aid for planning and evaluating the use of computers in the classroom. Written for teachers and administrators, the guide suggests criteria for assessing available computer and microcomputer hardware and software for instructional purposes. Among the topics covered are computer instruction site development and management and sources of hardware and software for education use.

A Planning Guide to Successful Computer Instruction costs $19.95. Contact Electronic Courseware Systems, POB 2374, Station A, Champaign, IL 61820, (217) 359-7099.
Circle 597 on inquiry card.

Educational Software Catalog

Aquarius Publishers is a new company that publishes and distributes educational software oriented toward junior and senior high-school students. Most of the programs run on TRS-80 and Apple II microcomputers. For a free catalog, contact Aquarius Publishers, POB 128, Indian Rocks Beach, FL 33535, (813) 595-7890.
Circle 598 on inquiry card.



Compatibility Guide

Nashua Corporation's new pocket-sized Compatibility Guide contains a complete list of all disk drives in use and the Nashua Corporation disk products developed for each. The guide provides a description of the disk pack and cartridge characteristics, a comparison table, and an illustration of a disk layout.

The Compatibility Guide is available from Nashua Corporation, Computer Products Division, 44 Franklin St., Nashua, NH 03061. ■
Circle 600 on inquiry card.

Trade-A-Computer

Trade-A-Computer is a monthly classified magazine dedicated to selling, buying, and trading new and used computer products. Trade-A-Computer has an online data-entry service called Ad-Line, a 300-bit-per-second software system that asks a series of questions concerning your ad, then composes the ad after completing its inquiry. There are no additional charges for this service.

Classified ads cost $1 per line; display ad rates are available. Ad-Line can be accessed by calling (215) 462-4415. Subscriptions cost $10 per year. Contact Trade-A-Computer, POB 15842, Philadelphia, PA 19103, (215) 462-4416.
Circle 599 on inquiry card.

Where Do New Products Items Come From?

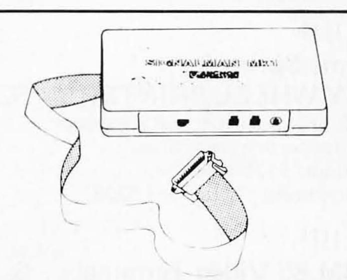
The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

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6502	7.45	10/6.95	50/6.55	100/6.15
6502A/6512A	8.40	10/7.95	50/7.35	100/6.90
6520 PIA	5.15	10/4.90	50/4.45	100/4.15
6522 VIA	6.45	10/6.10	50/5.75	100/5.45
6532	7.90	10/7.40	50/7.00	100/6.60
2114-L200		3.75	25/3.50	100/3.25
2114-L300		3.15	25/2.90	100/2.65
2716 EPROM		7.00	5/6.45	10/5.90
2532 EPROM				14.50
6116 Hitachi 2K x 8 CMOS RAM				**14.50**
4116				**8 for 17**
Zero Insertion Force 24 pin Socket				2.00
6550 RAM (PET 8K)				12.70
S-100 Wire Wrap Socket				2.40

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MODEM SPECIAL $99

SIGNALMAN Mk1 from Anchor Automation

DIRECT CONNECT Modem with RS232 Cable and Connector included. Fully compatible with all Bell 103 modems. 0 to 300 bps, full duplex, frequency shift keyed modulation, automatic ANSW/ORIG selection, direct connect, audible tone carrier detect indicator, self-contained battery powered.

PET/CBM Version (Mk1P) $169

For Commodore Computers, the Signalman Mk1P includes connector, cable, and machine language software (parallel port).

STAR MODEM Prentice/Livermore Data Systems

RS232 MODEM	**SALE**	**$128**
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RS232 CCITT		**$170**
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We carry Apple II+ from Bell & Howell



CASH MANAGEMENT SYSTEM $45
Easy to use. Keeps track of cash disbursements, cash receipts, cash transfers, expenses for up to 50 categories.

FORTH for PET by Cargile/Riley **$50**
Full FIG model with all 79 Standard extensions.
Metacompiler for FORTH for independent object code **30**

KMMM PASCAL for PET/CBM $85
Includes translator for true machine language object code.

EARL for PET/CBM 65
Editor, Assembler, Relocator, Linkeditor.

SuperGraphics - BASIC Language Extensions 30
Fast Machine Language Graphics routines for PET/CBM.

SM-KIT - Super PET/CBM ROM based Utilities 40

commodore



CBM-PET SPECIALS

	list	SALE
8023 Printer - 136 col, 150 cps bi-directional	(995)	775
8300 (Diablo 630) Daisy Wheel - 40 cps bi-directional	(2250)	1750
8032 80 x 25 CRT, business keyboard	(1495)	1100
Super Pet	(1995)	1650
8096 Board (extra 64K RAM for 8032)	(500)	400
8050 Dual Disk Drive - 1 megabyte	(1795)	1345
8250 Dual Disk Drive - 2 megabyte	(2195)	1760
CBM IEEE Modem	(395)	199
4016 full size graphics keyboard	(995)	795
4032 full size graphics keyboard	(1295)	999
4040 Dual Disk Drive - 330,000 bytes	(1295)	999
2031 Single Disk Drive - 165,000 bytes	(695)	550
4022 Tractor Feed Printer	(795)	630
C2N External Cassette Deck	(75)	65
VIC 20 Color Computer	(299)	259
VIC 1515 Graphic Printer	(395)	335
Used CBM/PET Computers		CALL
8024-7 High Speed Printer	(1995)	1345

WE WILL MATCH ANY ADVERTISED PRICE

***** EDUCATIONAL DISCOUNTS *****
Buy 2 PET/CBM Computers, receive 1 FREE

WordPro 3 Plus - 32K CBM, disk, printer	215
WordPro 4 Plus - 8032, disk, printer	325
OZZ Data Base System for CBM 8032	335
VISICALC for PET, ATARI, or APPLE	155
SM-KIT - Super PET ROM Utilities	**40**
Programmers Toolkit - PET ROM Utilities	35
PET Spacemaker II ROM Switch	36
2 Meter PET to IEEE or IEEE to IEEE Cable	40
Dust Cover for PET	7
IEEE-Parallel Printer Interface for PET	110
IEEE-RS232 Printer Interface for PET	120
The PET Revealed	17
Library of PET Subroutines	17

RAM/ROM for PET/CBM
4K or 8K bytes of soft ROM with optional Battery Backup.
Adds extra RAM which can be write protected like ROM.
4K Version - $85 8K Version - $120 Battery Backup - $30

EPROM Programmer for CBM/PET 79
Branding Iron with software/hardware for 2716 and 2532.

Watanabe Intelligent Plotter

WATANABE WX4671 Plotter	**1195**
WATANABE WX4675 6-pen Plotter	**1445**

DISK SPECIALS



SCOTCH (3M) 5"	10/2.75	50/2.65	100/2.60
SCOTCH (3M) 8"	10/2.80	50/2.70	100/2.65
Verbatim 8" Double Dens.	10/3.45	50/3.35	100/3.20
Verbatim 5" Datalife	10/2.45	50/2.40	100/2.35
(add 1.00 for Verbatim 5" plastic storage box)			
BASF 5" soft	10/2.40	20/2.35	100/2.30
Wabash 5" in Plastic Box	10/2.70	50/2.60	100/2.50
Wabash 8" in Plastic Box	10/2.75	50/2.65	100/2.55

WE STOCK MAXELL DISKS

Diskette Storage Pages		10 for 3.95
Disk Library Cases	8" - 2.85	5" - 2.15
Disk Hub Rings	8" - 50 for 7.50	5" - 50 for 6.00

CASSETTES - AGFA PE-611 PREMIUM
High output, low noise, 5 screw housings.

C-10	10/.56	50/.50	100/.48
C-30	10/.73	50/.68	100/.66

All other lengths available. Write for price list.

SPECIALS

EPSON MX-80 Printer
EPSON MX-80 F/T Printer
EPSON MX-70 Printer
EPSON MX-100 Printer

Centronics 739 Printer with dot graphics	675
STARWRITER Daisy Wheel Printer	**1445**
Zenith ZVM-121 Green Phosphor Monitor	119
Amdek Color Monitor	355

ALL BOOK and SOFTWARE PRICES DISCOUNTED
OSBORNE/McGraw-Hill, HAYDEN, SYBEX, etc.

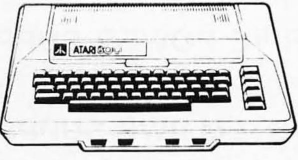
Synertek Systems

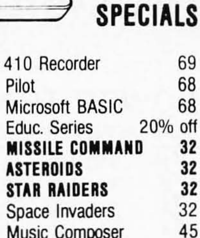
SYM-1 Microcomputer SALE	**199**
SYM BAS-1 BASIC or RAE 1/2 Assembler	85
KTM-2/80 Synertek Video and Keyboard	349
KTM-3/80 Synertek Tubeless Terminal	385



Z90-80 64 K	2170
Z90-82 64K, 1 double dens. drive	2395
Z89-0 48K	1950
Z89-1 48K, 1 drive	2150
Z67 10 Megabyte + Floppy Drive	4495
Z37 1.3 Megabyte Dual Floppy	1495
Z25 High Speed Printer	1195
Z19 Video Terminal (VT-52 compatible)	670
ZVM-121 Green Phosphor Monitor	119

All Zenith Software discounted





ATARI® SPECIALS

800 Computer	695	410 Recorder	69
400 - 16K	339	Pilot	68
810 Disk Drive	449	Microsoft BASIC	68
825 Printer	629	Educ. Series	20% off
850 Interface	175	**MISSILE COMMAND**	**32**
822 Printer	359	**ASTEROIDS**	**32**
Paddle Pair	17	**STAR RAIDERS**	**32**
Joystick Pair	17	Space Invaders	32
16K RAM	85	Music Composer	45
Assembler/Editor	46	Chess	30
TeleLink	20	Super Breakout	30

Write for prices on other Atari items.

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A B Computers

WRITE FOR CATALOG
Add $1.25 per order for shipping. We pay balance of UPS surface charges on all prepaid orders. Prices listed are on cash discount basis. Regular prices slightly higher. Prices subject to change.

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FLOPPY DISK DRIVES

SPECIAL!!!!!!!! QUME DATATRAK 8

Virtually the industry standard. High quality/reliability. Full featured, double sided, double density.

1-5	$499
6-9	$485
10	$475

TANDON DOUBLE SIDED, DOUBLE DENSITY MINIS

TM100-2 .... 48 TPI (500 KBYTES) $325
Compatible with Northstar, Cromemco, TRS-80

TM100-4 .... 96 TPI (1000 KBYTES) $425
Compatible with Zenith, Heath, etc.

TANDON 5¼" HARD DISKS

TM 602 (5MB) $1195
TM 603 (10MB) $1295

CPU

CCS 2810	$ 275
Godbout Z-80A	$ 275
Godbout 8085A	$ 295

MEMORY

CCS 2065 64K dynamic	$ 595
CCS 2116 32K static	$ 625
Godbout RAM 17 64K	$ 675

I/O

CCS 2710 4 SIO	$ 325
Godbout Interfacer 1	$ 225
Godbout Interfacer 2	$ 225

CONTROLLERS



Tarbell single density kit	$195
Tarbell single density A & T	$310
Tarbell double density A & T	$425
CCS 2422 w/CPM 2.2	$350
Godbout Disk 1	$450
MDA MXV-21 LSI-11 controller (RX-01, RX-02 compatible)	$1050

NEW !!!!
Qume Sprint 9
DAISY WHEEL PRINTER .. $2395
45 CPS, RO. Available in KSR version.
Call for further particulars.
Ribbons: $125/case
Bidirectional tractor feed $225

NEW !!!!
ABM 85 Video Terminal .. $ 895
- Detachable keyboard
- Televideo 920, ADM 3A compatible
- High resolution green phosphor (23 MHZ)
- Extra multi-bus or S-100 slot for stand-alone capability

MISCELLANEOUS

2 Disk drive enclosure ..... $ 95
(fits Siemens, Shugart, Qume)
CP-206 power supply $110
(powers two floppies)

Mini-Enclosure with power supply
1 drive ...... $ 85
2 drives $120

Cable Kits 2 drives ...... $ 35
3 drives ...... $ 40
4 drives ...... $ 45
Diskettes ss $39/10 — ds $59/10

Electrolabs

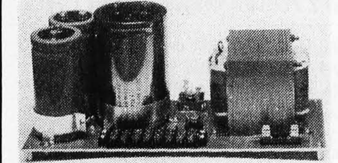
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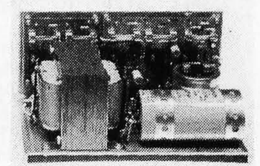
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POWER SUPPLIES

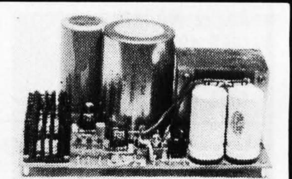
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KIT 1, 2 & 3 For S−100



R3 For Three 8" or 5¼" Disk Drives



S3 2 in 1 Unit for S−100 and two 8" or 5¼" Disk Drives. It fits most Disk System Mainframes.

S-100 POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

ITEM	USED FOR	@ + 8 Vdc	@ − 9 Vdc	@ + 16 Vdc	@ − 16 Vdc	@ + 28 Vdc	SIZE W × D × H	PRICE
KIT 1	15 CARDS SOURCE	15A	———	2.5A	2.5A	———	12" × 5" × 4⅞"	54.95
KIT 2	SYSTEM SOURCE	25A	———	3A	3A	———	12" × 5" × 4⅞"	61.95
KIT 3	DISK SYSTEM	15A	1A	2A	2A	4A	14" × 6" × 4⅞"	69.95

DISK DRIVE POWER SUPPLY "R3" REGULATED, OPEN FRAME, ASSY. & TESTED 69.95

SPECS: + 5V @ 5A OVP, −5V @ 1A + 24V@ 5A, SHORTS PROTECT. 2 SIZES AVAIL., 1.) 9" (W) × 6¼" (D) × 4⅜" (H), 2) 9" (W) × 4⅞" (D) × 5¼" (H)
OPTION: 1.) REPLACE + 24V BY + 12V, 2.) FOR SIZE 1 ONLY, ADD ± 12V @ 1A, AT AN ADDITIONAL $12.00.
IDEAL FOR THREE 8" or 5¼ FLOPPY DISK DRIVES, SUCH AS SHUGART 801/851, SIEMANS FDD 100-8/200-8 OR 100−5 ETC.

DISK SYSTEM PWR SUPPLY "S3" OPEN FRAME, ASSY. & TESTED. COMPACT SIZE: 10"(W) × 6" (D) × 5" (H) 97.95

REGULATED OUTPUTS FOR DISK DRIVES: +5V @ 4A, −5V @ 1A, +24V @ 4A (OR + 12V @ 4A). SHORTS PROTECT.
UNREGULATED OUTPUTS FOR S−100: +8V @ 14A, ± 16V @ 3A. (OPTION: ADD OVP FOR +5V, ADD $5.00)
A COMPLETE UNIT FOR DISK SYSTEM WITH THE MAINFRAME CONTAINING 12 SLOTS & TWO 8" or 5¼" DISK DRIVES.

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

ITEM	PRIMARY	SECONDARY #1	SECONDARY #2	SECONDARY #3	SIZE W × D × H	PRICE
T_1	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	———	3¾" × 3⅝" × 3⅛"	22.95
T_2	110/120	2 × 8 Vac, 25A	28 Vac, CT, 3.5A	———	3¾" × 4⅜" × 3⅛"	28.95
T_3	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	48 Vac, CT, 2A	3¾" × 4⅜" × 3⅛"	30.95
T_4	110/120	2 × 8 Vac, 6A	28 Vac, CT, 1.5A	48 Vac, CT, 3A	3¾" × 3⅝" × 3⅛"	23.95
T_5	110/120	2 × 8 Vac, 6A	28 Vac, CT, 2A	———	3" × 3" × 2½"	15.95

SHIPPING For each power supply $5.50 in Calif., $8.00 in other states, $18.00 in Canada. For each Transformer $5.00 in all States, $12.00 in Canada. Calif. Residents add 6% Sales Tax.



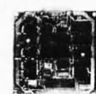
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CRT CONTROLLER



This intelligent CRT Controller uses an 8085A CPU & an 8275 Integrated CRT Controller. it features:

- 25 lines (80 char./line)
- 5x7 dot matrix
- Upper & lower case
- Two 2716's (controller & char. generator)
- Serial interface RS232 & TTL
- Baud rates of 110, 150, 300, 600, 1200, 2400, 4800 and 9600
- Keyboard scanning system
- Unencoded keyboard required
- Uses +5V & ±12V Power Supplies
- Does not have graphic capabilities.

Documentation includes program listing and composite video circuit.

Bare Board only (with doc)	$39.95
2716 Char. Gen. A7	$19.95
2716 Program A12	$19.95

A-D CONVERTER



JBEs 16 channel A-D Converter plugs into your Apple II computer. It uses an ADC0817 which incorporates a 16 channel multiplexer and an 8 bit A-D Converter. The 16 inputs are high impedance and the voltage range is 0 to 5.12 volts. Conversion time is <100μsec. The resolution is 8 bits or 256 steps, linearity is ± 1/2 step. Two 16 pin DIP sockets are used for input, GND & reference voltage connections. There are 3 single bit TTL inputs. Doc. Includes sample program.

81-132A Assm.	$89.95
81-132K Kit	$69.95
81-132B Bare Board	$29.95

EPROM PROGRAMMER

JBE's EPROM Programmer is designed to program 5V 2516's, 2532's & 2716's. It interfaces to the JBE Parallel I/O card using four ribbon cables. An LED indicates when the EPROM is being programmed. A textool zero insertion force socket is used for the EPROM. Comes with complete documentation for writing and reading EPROM's in the Apple II or Apple II Plus. Cables available separately.

80-244A Assm.	$49.95
80-244K Kit	$39.95
80-244B Bare Board	$24.95

PARTS

6502 MPU	$9.95
6522 VIA	$9.95
Z-80 MPU	$9.95
Z-80 PIO	$9.95
TWO 2114 RAM	$9.95
2716	$14.95
50 pin conn.	$5.95
Dip Jumper 2 ft.	$4.95

6522 APPLE II INTERFACE

The JBE 6522 Parallel Interface for the Apple II Computer, plugs directly into any slot 1 through 7 in the Apple. This card has 2 6522 VIA's that provide:

- Four 8 bit bi-directional I/O ports
- Four 16 bit programmable timer/counters
- Serial shift registers
- Handshaking

A 74LS05 is for timing. Four 16 pin sockets provide easy connections to other peripheral devices. (Dip jumpers with ribbon cables are also available from JBE) The 6522 Parallel I/O card interfaces to the JBE EPROM programmer. Understanding of machine language required to use this board. Inputs and outputs are TTL compatible.

79-295A	$69.95 Assembled
79-295K	$59.95 Kit
79-295B	$19.95 Bareboard

SPEECH SYNTHESIZERS

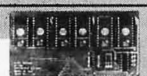
JBEs Speech Synthesizers use the Votrax SC-01 Phoneme Synthesizer chip. The SC-01 phonetically synthesizes continuous speech of unlimited vocabulary. The SC-01 contains 64 different phonemes and 4 levels of inflection accessed by an 8 bit code. It requires 10 Bytes per second for continuous speech. Both boards have an audio amp for direct connection to an 8 ohm speaker.

Documentation includes basic user programs, a phoneme chart and listing of coded words to help you get started. Documentation for the Apple II® Speech Synthesizer includes a disk with many user programs.

81-088 Apple II Speech Synthesizer	$139.95
81-120 Parallel Input Speech Synthesizer	$149.95

Prices include the SC-01 Chip
SC-01 sold separately for $ 75.95

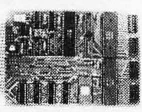
EPROM EXPANSION CARD



JBE EPROM Expander for the Apple II holds six 5V 2716s for a total of 12K bytes of EPROM. This board takes the place of the on board ROM in the Apple. It is software switchable by the same technique used by the Apple II firmware card. Solder jumpers are for reset to the Apple ROM or EPROM Expansion Card. Use JBE EPROM Programmer and Parallel I/O to program your EPROMs. EPROMs sold separately.

81-085A Assm.	$59.95
81-085K Kit	$49.95
81-085B Bare Board	$39.95

81-260 "SLIM"



Single board large scale Integration Microcomputer. This 4.5 x 6.5 board uses the 6502 Microprocessor, two 6522 VIA's, four 2114 RAM's, 2516, 2716 or 2532 EPROM. The fully buffered 22/44 pin bus is similar to the KIM®, SYM®, and AIM® expansion connector. The four 8 bit I/O ports connect through 16 pin dip sockets. This board was designed for control and is ideal for Personal and OEM use.

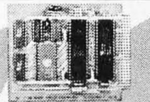
- 6502 MPU
- Two 6522 VIA's
- Four 2114 RAM's (2K bytes)
- One EPROM 2516 or 2532
- Crystal clock 1 Mhz
- Requires 5V 1AMP Power
- 4.5 x 6.5 card
- Power on reset
- Fully buffered-expandable
- Solder mask-both sides

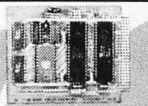
Use your Apple II Computer, JBE 6522 Parallel Interface card and EPROM Programmer as a development system for SLIM.

Prices:

81-260A	$199.95 Assembled
81-260K	$149.95 Kit
81-260B	$ 39.95 Bare Board

6502 MICROCOMPUTER



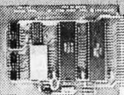


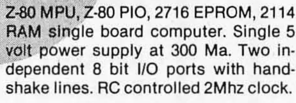
6502 MPU, 6522 VIA, 2716 EPROM, 2114 RAM single board computer. Single 5 volt power supply at 400 Ma. Two independent 8 bit I/O ports with handshake lines. RC controlled 1 Mhz clock.

Complete documentation. I/O lines use 50 pin edge connector. Data and address lines are not accessible. Mod. for 2532 is included. EPROM is not included. 1K RAM, 2K EPROM, 2 I/O ports.

80-153 Assm.	$110.95
80-153 Kit	$ 89.95
80-153 Bare Board	$ 19.95

Z-80 MICROCOMUTER



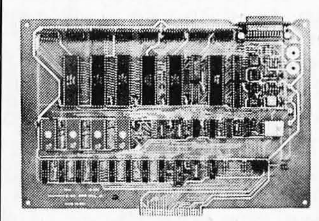


Z-80 MPU, Z-80 PIO, 2716 EPROM, 2114 RAM single board computer. Single 5 volt power supply at 300 Ma. Two independent 8 bit I/O ports with handshake lines. RC controlled 2Mhz clock.

Complete documentation. I/O lines use 50 pin edge connector. Data and address lines are not accessible. Mod. for 2532 is included. EPROM is not included. 1K RAM, 2K EPROM, 2 I/O ports.

80-280 Assm.	$129.95
80-280 Kit	$119.95
80-280 Bare Board	$ 19.95

JBE I MICROCOMPUTER



JBE's 7.75 x 11.75 6502 base Microcomputer has the capacity for 16K of EPROM, 4K of RAM, 8 Parallel Ports and 1 Serial Port. Monitor and Tiny Basic are also available. The fully populated version includes:

- 1 6502 CPU
- 4 6522 VIA (8 Parallel I/O Ports)
- 1 AY5-1013 (Serial I/O Ports)
- 8 2114 RAM (4K)
- 2 2716 EPROM (Monitor & Tiny Basic)

The partially populated version includes:

- 1 6502 CPU
- 1 6522 VIA (2 Parallel I/O Ports)
- 1 AY5-1013 (Serial I/O Port)
- 2 2114 RAM (1K)
- 1 2716 EPROM (with Monitor)

Both versions include sockets for 2716s or 2532s, 8 16 pin sockets for I/O interfacing and a DB25 connector for RS232.

All address and data lines are brought off the board to the 50 pin edge connector. (similar to the Apple II bus)

This board also features power on reset and cassette interface.

81-030 C Fully Populated	$349.95
81-030M Partially Populated	$249.95
81-030B Bare Board	$ 89.95
2716 EPROM (with Monitor)	$ 19.95
2715 EPROM (with Tiny Basic	$ 19.95

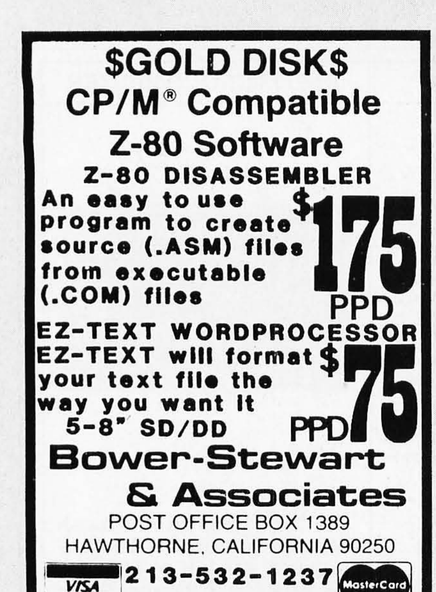


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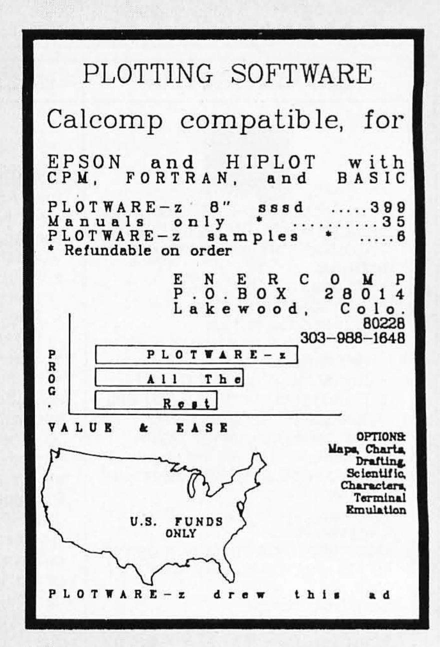
VISA



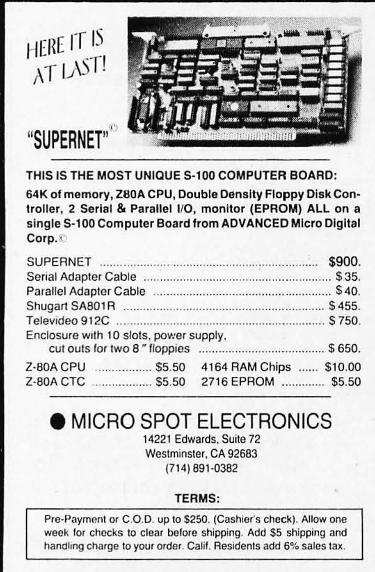
Circle 50 on inquiry card.



Circle 94 on inquiry card.



Circle 154 on inquiry card.



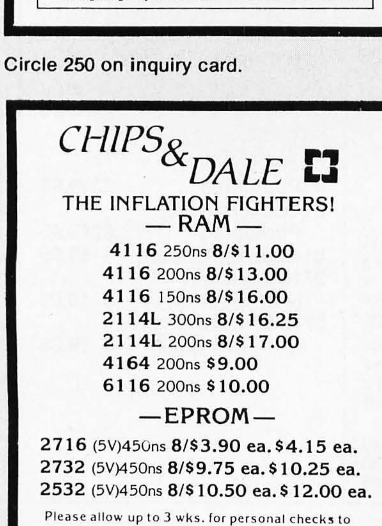
Circle 250 on inquiry card.



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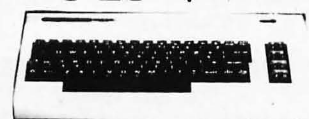
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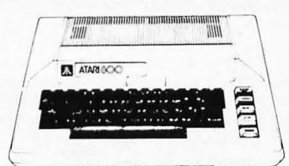
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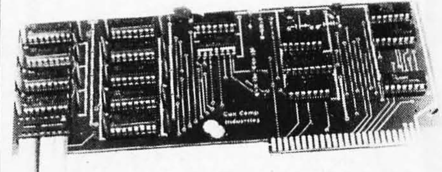
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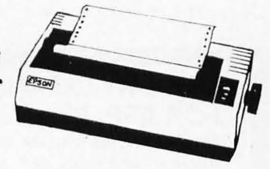
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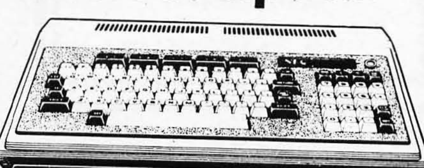
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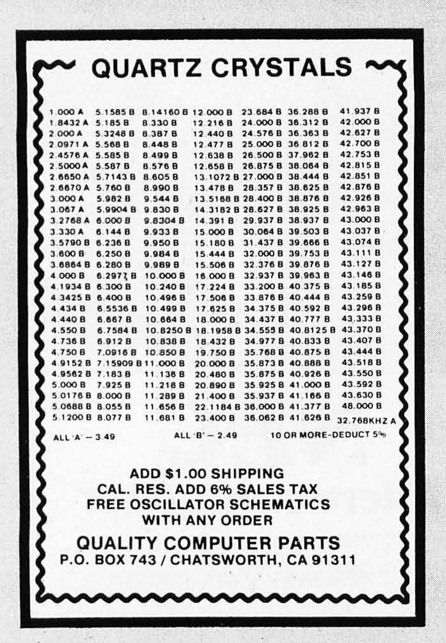
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3.2768 A	6.000 B	9.8304 B	14.391 B	29.937 B	38.937 B	43.000 B
3.330 A	6.144 B	9.933 B	15.000 B	30.064 B	39.503 B	43.037 B
3.5790 B	6.236 B	9.950 B	15.180 B	31.437 B	39.666 B	43.074 B
3.600 B	6.250 B	9.984 B	15.444 B	32.000 B	39.753 B	43.111 B
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4.000 B	6.2977 B	10.000 B	16.000 B	32.937 B	39.963 B	43.146 B
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4.3425 B	6.400 B	10.496 B	17.506 B	33.876 B	40.444 B	43.259 B
4.434 B	6.5536 B	10.499 B	17.625 B	34.375 B	40.592 B	43.296 B
4.440 B	6.667 B	10.664 B	18.000 B	34.437 B	40.777 B	43.333 B
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5.000 B	7.925 B	11.218 B	20.890 B	35.925 B	41.000 B	43.592 B
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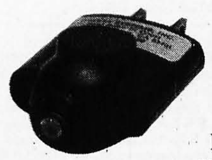


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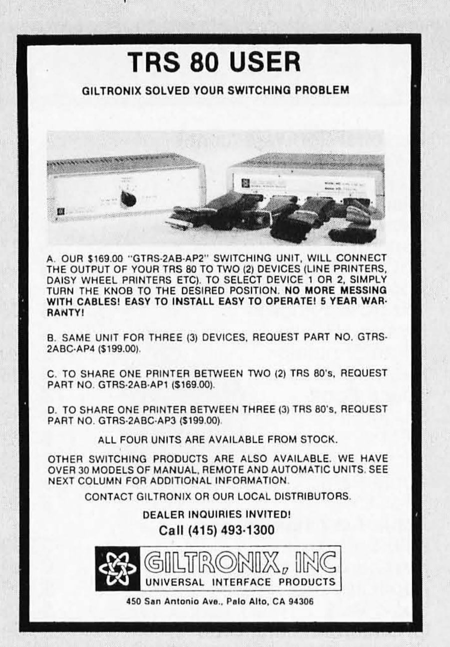


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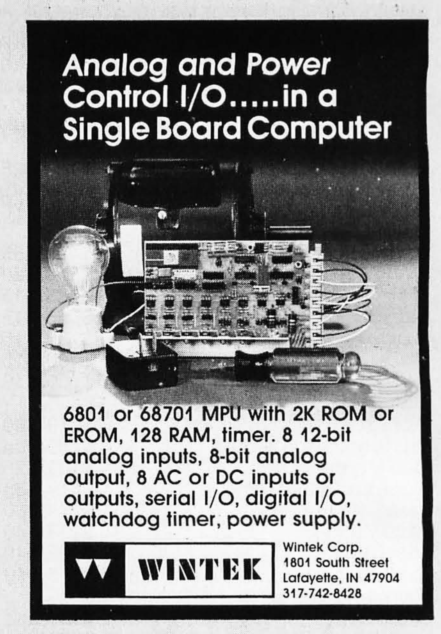
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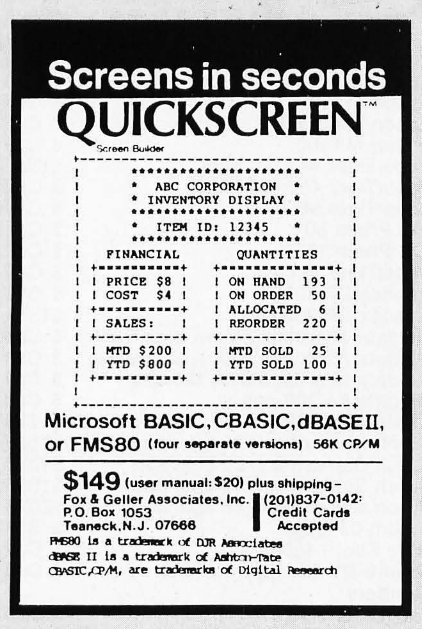
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10.0MHZ	Series
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18.431MHZ	Series
48.0MHZ	Series

EPROMS

2708	AMD	3 Supply	45ONS	3.50
2716	Hitachi	+5	45ONS	7.00
2716	National	+5	45ONS	7.00
2716	Intel	+5	45ONS	7.00
2716-1	Intel	+5	35ONS	9.50
2716	T.I.	3 Supply	45ONS	7.50
2716	Motorola	3 Supply	45ONS	7.50
2732	NEC	+5	45ONS	16.00
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Belmont, California 94002

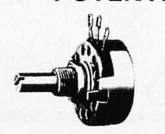
One-Stop Component Center ™

This is a partial listing of over 600 items available from 600 authorized Jim-pak Distributors:

TTL

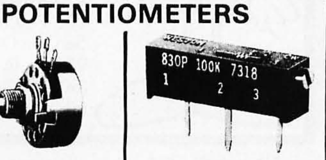
7400	2/.85	7490	.85
7402	2/.85	7493	.85
7404	2/.85	74100	2.25
7406	2/1.19	74109	2/1.19
7407	2/1.19	74121	.69
7408	2/.89	74123	.99
7410	2/.85	74150	1.95
7414	.99	74154	1.95
7417	2/1.10	74157	.99
7420	2/.85	74161	1.19
7447	1.19	74164	1.59
7474	.69	74174	1.59
7475	.79	74175	1.49
7476	.69	74192	1.19
7485	1.19	74193	1.19
7486	2/1.19	74367	.99
7489	2.99	74393	1.95

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2 Watt @ 70°C
7/8" Slotted Shaft
Linear Taper
1K, 5K, 10K, 25K, 50K, 100K, 1 Meg

CMU $2.95



3/4 Watt @ 70°C
15 Turn Pot.
Linear Taper
100 Ohm, 500 Ohm, 1K, 5K, 10K, 50K, 100K, 500K, 1Meg

830P $1.79

5-WAY DC VOLTAGE ADAPTER
With Universal Plug & 9V Battery Snap

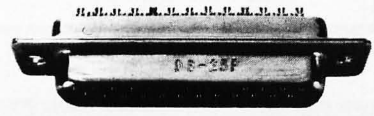
Selective voltage: 6,9,12VDC. Pol. selection (+/-). 6' line — adapter to plugs. 6" line — adapter to batt. snap. 120V/60Hz. 300mA.

DC6912 .... $9.95

CMOS

4000	.55	4030	.75
4001	.55	4040	1.79
4002	.59	4044	1.39
4006	1.49	4046	1.95
4009	.79	4047	2.75
4010	.79	4049	.79
4011	.55	4050	.89
4013	.75	4051	1.59
4016	.79	4066	.95
4017	1.39	4069	.69
4018	1.39	4070	.75
4020	1.39	4071	.69
4023	.49	4081	.59
4024	1.19	4093	1.19
4027	.79	4511	1.95

CONNECTORS



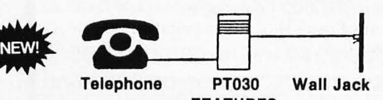
DB25P	D-Subminiature Plug	3.95
DB25S	D-Subminiature Socket	4.95
DB51226	Cover for DB25P/S	2.25
22/44SE	P.C. Edge	2.95
UG88/U	BNC Plug	2.19
UG89/U	BNC Jack	3.95
UG175/U	UHF Adapter	.59
SO239	UHF Panel Recp.	1.49
PL258	UHF Adapter	1.95
PL259	UHF Plug	1.95
UG260/U	BNC Plug	2.39
UG1094/U	BNC Bulkhead Recp.	1.49

LINEAR

LM301N	.59	LM7805T	1.75
LM305H	1.39	LM7812T	1.75
LM307N	.75	LM7815T	1.75
LM308N	1.19	LM380N	1.49
LM309K	2.25	LM384N	2.49
LM310N	2.69	LM555N	.69
LM311N	1.49	LM556N	1.49
LM317T	2.29	LM565N	1.95
LM318N	2.95	LM566N	1.95
LM319N	2.95	LM567N	1.79
LM320K-5	2.25	LM723N	.79
LM7905T	1.75	LM741N	.65
LM7912T	1.75	LM1310N	2.95
LM7915T	1.75	LM1458N	.99
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FEATURES

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AD30 AC Adapter $8.95

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General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:

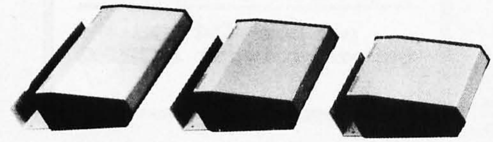
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp)	$14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp	$19.95

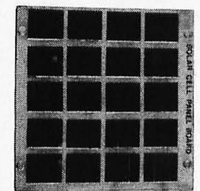
DESK TOP ENCLOSURES



DTE-8 (Pictured)	$31.95
DTE-11 (Pictured)	34.95
DTE-14 (Pictured)	36.95
DTE-HK (Case for JE600)	47.95
DTE-AK (Case for JE610)	52.95

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- Output: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel
- Panel may be easily connected for Series or Parallel out
- Over 11 square inches of active cell surface
- Voltage line tap @ 0.5V increments
- Provision for charging batteries
- Overall panel size: 4¾"L x 4½"H x ½"D

The JE305 Solar Cell Panel Kit contains 20 ea. solar cells. On the panel board are power line taps which allow the user to select voltages (1 voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players & unlimited experimental solar projects.

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74LS10	.55	74LS154	1.95
74LS14	1.09	74LS157	1.19
74LS30	.55	74LS161	1.29
74LS32	.69	74LS174	1.19
74LS38	.69	74LS175	1.19
74LS42	1.29	74LS192	1.49
74LS47	1.29	74LS193	1.49
74LS48	1.79	74LS221	1.49
74LS73	.75	74LS244	1.89
74LS74	.69	74LS245	3.49
74LS75	.75	74LS367	.89
74LS85	1.49	74LS374	1.95
74LS90	.89	81LS97	2.29

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22 pin LP	2/1.09	40 pin WW gold	2.75
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28 pin LP	.82	16 p. plug/cover	1.39
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IN1188	2.69	2N2907A	2/.89
IN3600	5/.99	2N3055	.99
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IN4004	4/.69	2N3904	2/.69
IN4007	4/.79	2N3906	2/.69
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IN4733	2/.69	2N4403	2/.79
IN4734	2/.69	2N5129	2/.69
IN4735	2/.69	2N5139	2/.69
IN4742	2/.69	2N5210	2/.79
IN4744	2/.69	2N5951	2/1.29

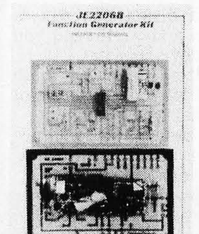
CAPACITORS

Dipped Tantalum		ELECTROLYTIC	
.1mfd @ 35V	2/.89	1mfd @ 50V	3/.69
.47mfd @ 35V	2/.89	4.7mfd @ 50V	2/.59
1mfd @ 35V	2/.89	10mfd @ 50V	2/.69
2.2mfd @ 25V	2/1.09	22mfd @ 50V	2/.79
3.3mfd @ 25V	2/1.19	47mfd @ 50V	2/.89
4.7mfd @ 25V	2/1.39	100mfd @ 50V	.59
10mfd @ 25V	1.19	220mfd @ 50V	.69
33mfd @ 25V	3.95	1000mfd @ 25V	1.19
		2200mfd @ 16V	1.39
100V MYLAR		**50V CERAMIC**	
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.1mfd	4/1.19		
.22mfd	4/1.29		

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MK4116	16K Dynamic RAM (250ns)	3.95
2708	8K EPROM	5.95
2716	16K EPROM (+5V)	9.95

Function Generator Kit

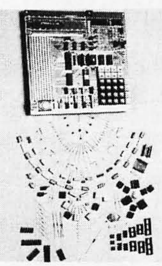


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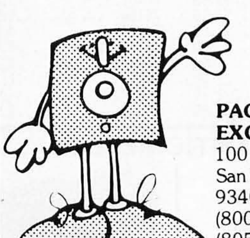
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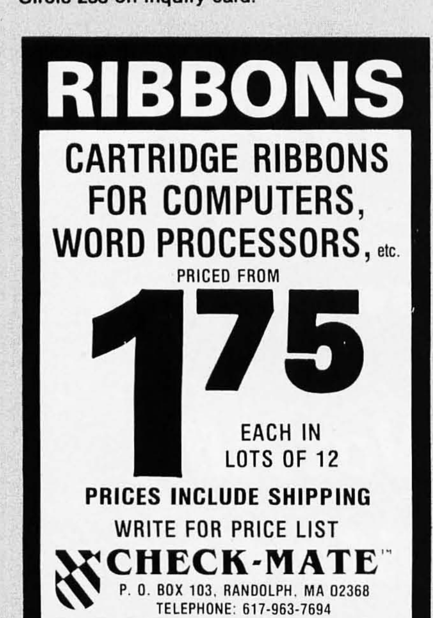
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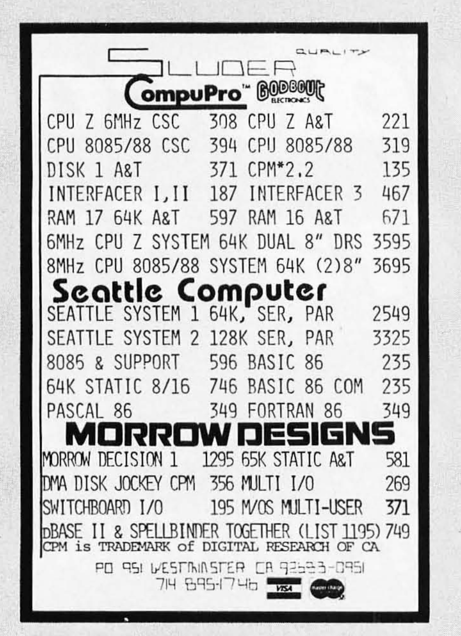
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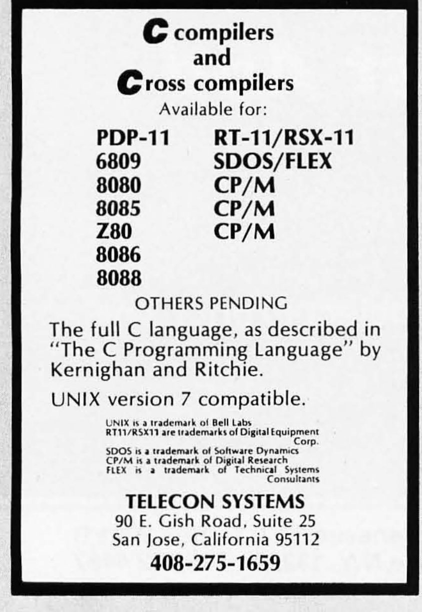
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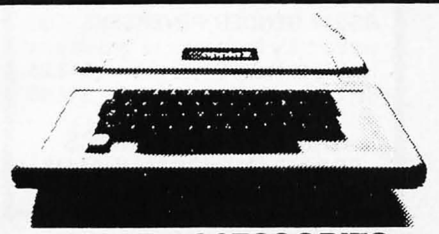




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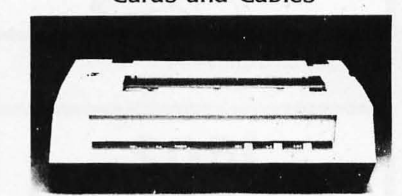
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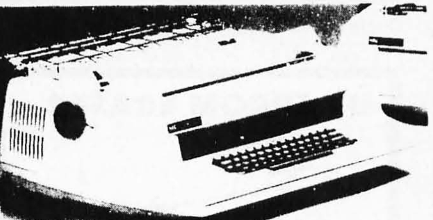
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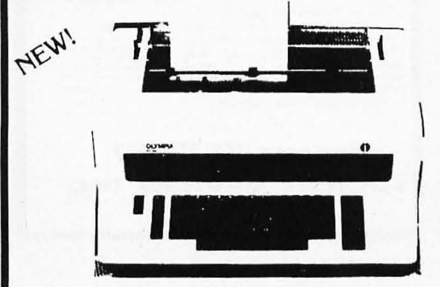
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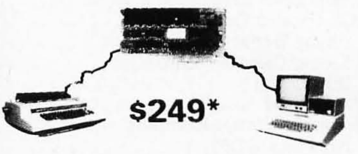
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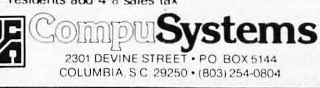
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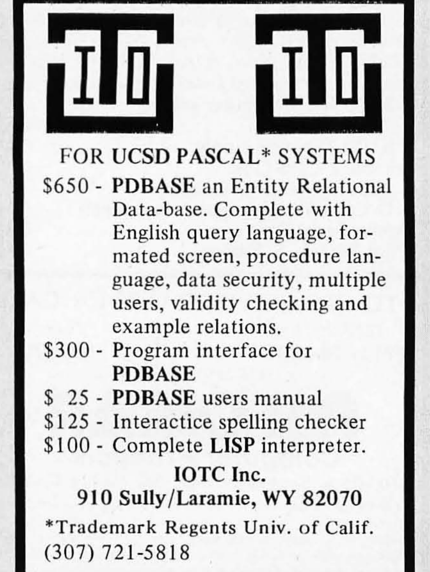
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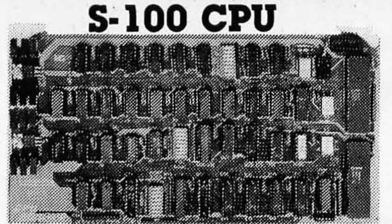


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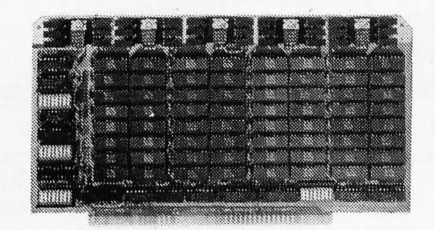
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VBBB - S.S.M.

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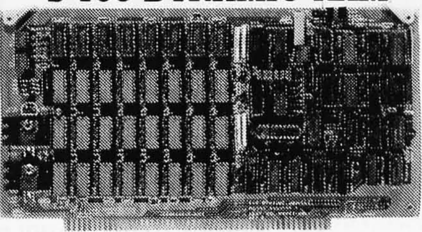
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S-100 DYNAMIC RAM



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THE EXPANDABLE 1™ 64K Dynamic Ram board provides your S-100 system with 64K of reliable, high-speed dynamic RAM. Compatable with most of the major S-100 systems on the market, including those with front panels, it supports DMA operations and requires no Wait states with current microprocessors. • User expandable from 16 to 64K • Supports DMA • Designed to IEEE proposed S-100 bus standards • 2 or 4 MHz operation • Operates with either an 8080 or Z-80 based S-100 system, providing processor-transparent refreshes with both • Supports IMSAI-type front panels • Jumper-selectable Phantom input • Uses Popular 4116 RAMS • All ICs in sockets • Any 16K block can be made bank-independent • Fully buffered address and data lines • Fail-safe refresh circuitry for extended Wait states • Board configuration with reliable, easy-to-configure Berg jumpers

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BCPRIEXP132	32K Assembled & Tested	$339.00
BCPRIEXP148	48K Assembled & Tested	$379.00
BCPRIEXP164	64K Assembled & Tested	$409.00

S-100 DISK CONTROLLERS

2422A - CA. COMP. SYST.

I/O Mapped, controls 8", single or double density A&T with CPM 2.2 8" S.D.

	LIST PRICE	OUR PRICE
BCCCS2422A	$475.00	$375.00

DISK JOCKEY 2D - MORROW

Memory Mapped, controls 8", single or double density, serial I/O

BCMDIDJ2208	A&T with CP/M 2.2	$399.00	$375.00

S-100 DISK SUBSYSTEMS

DJ2B DISCUS SINGLE SIDED MORROW

8" DBL Density drives with cabinet, power supply controller, with CP/M 2.2 and Microsoft Basic

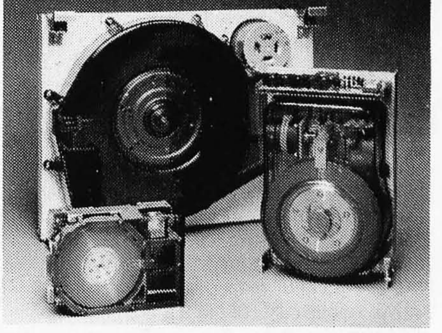
BCMDSF1218	Single Drive System	$1095.00	$950.00
BCMDSF1228	Dual Drive System	$1875.00	$1598.00

DJ2B DISCUS DOUBLE SIDED - MORROW

8" DBL Density/sided drives with cabinet Power supply controller, with CP/M 2.2 and Microsoft Basic

BCMDSF2218	Single Drive System	$1395.00	$1250.00
BCMDSF2228	Dual Drive System	$2495.00	$2050.00

S-100 HARD DISK - MORROW



5.25" 5MB, 8" 10 & 20MB, 14" 26MB formatted hard disk complete with cabinet, P.S., Controller, CP/M 2.2 and Microsoft MBASIC 80

		LIST PRICE	SALE PRICE
BCMDCMAM5	5 MB	$2495.00	$1995.00
BCMDSM10S	10 MB	$3695.00	$2950.00
BCMDSM20S	20 MB	$4795.00	$3825.00
BCMDSM26S	26 MB	$4495.00	$3495.00

WOW!

VIDEO MONITORS

VM121 - ZENITH

15 MHz 12" P31 Green phosphor 40 or 80 characters per line

BCZVM121	20 lbs.	$159.00	$139.00

VM4509 - SANYO

10MHz, 9" 16 x 64 P4 B&W monitor

BCSYOVM4509	15 lbs.	$235.00	$198.00

DM5012 - SANYO

18MHz, 12" 24 x 80 P4 B&W monitor

BCSYODM5012	24 lbs.	$340.00	$310.00

DM5112 - SANYO

18MHz, 12" 24 x 80 P31 Green on Black display

BCSY05112	24 lbs.	$360.00	$325.00

VM6013 - SANYO

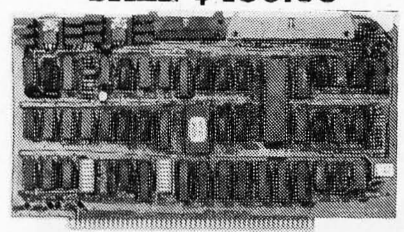
COLOR 13" 16 line x 64 character monitor

BCSYOVM6013	35 lbs	$550.00	$495.00

Circle 317 on inquiry card.

PRIORITY ONE ELECTRONICS

GODBOUT DMA DISK 1 WITH FREE CP/M 2.2 SALE $450.00



SAVE $220.00

Priority 1 Electronics is pleased to offer the GODBOUT DISK 1 High Performance Disk Controller at our regular low price with CP/M 2.2 and BIOS at no additional cost. That's a savings of $220.00 of the manufacturer's list price.

- Third generation INTEL 8272/NEC 765A LSI floppy disk controller.
- High speed cycle stealing DMA interface for processor independent data transfer between system memory and flexible disk.
- Handles up to four 8 or 5.25 inch floppy disk drives
- Single or double density/single or double sided capability.
- Supports IBM 3740 soft sectored formats.
- 24 bit DMA addressing with data transfer across 64K boundaries for data transfer throughout the 16Mbyte memory map.

PART NO.	DESCRIPTION	LIST PRICE	OUR PRICE
BCPDB171ACPM	A&T w/CP/M 2.2 & BIOS	$670.00	$450.00
BCGBT171C	CSC	$595.00	$555.00
BCGBTCPM80*	CP/M 2.2 for Z80/8085 with manuals & BIOS 8" S/D disk		$175.00
BCGBTOAS8S	Oasis 8 bit single user 8" S/D disk		$500.00
BCGBTOAS8M	Oasis 8 bit multiuser, 8" S/D disk		$850.00

S-100 SYSTEMS

SUPERSIXTEEN — GODBOUT

HERE IS WHAT EACH PACKAGE INCLUDES:

BCGBT1612A 6 MHz 8085/8088 Dual Processor Board
BCGBT171A High Speed DMA Disk Controller
BCGBT162A System Support 1 Multi-Function Board
BCGBT133A Interfacer 1 Dual Serial I/O
BC128K 10MHz Low Power Static Ram
BCGBTCP/M 86 16 Bit Operating System Ready to Load & Go
Cables and Documentation Three interfacer cables one disk I/O cable, complete documentator for all hardware, and manuals for both CP/M operating systems.
Compu Pro's famous **1 Year** limited warranty.

Now to the best part of all. If purchased separately, these quality components would list for $4,344.00. **BUT SuperSixteen's low package price is an amazing $3,495.00. You save $849.00!**(For boards qualified under the Certified System Component high-reliability program - with extended 2 year warranty, 200 hour burn-in and 8 MHz processors - add $600.00 to the package price. Sh. Wt. 15 lbs.

BCPDBGBTSJ	SuperSixteen A&T	$3495.00
BCPDBGBTSK	SuperSixteen CSC	$4095.00

PRINTERS





MICROLINE — OKIDATA WITH FRICTION AND TRACTOR FEED

- BI-DIRECTIONAL - 120 CPS
- 9x9 Matrix (Alphanumeric)
- 6x9 or 12 Matrix for Graphics
- 5,8.3, 10,16 Charactrs p/Inch
- 6 or 8 Lines per Inch
- 80 CPL@10 CPI for 82A
- 132 CPL@10 CPI for 83A
- Parallel and Serial I/O
- 100 Thru 1200 Baud
- Self Test
- Out of Paper Switch
- Friction or Tractor Feed
- 3" to 14" Top of Form (Switch Selectable)
- 10 Different Character Sets

PART NO.	DESCRIPTION	LIST PRICE	SALE PRICE
BCOKIDAT82AT(26 lbs)	8 80 CPL @10 CPI	$ 799.00	$539.00
BCOKIDAT83AT (37 lbs)	132 CPL @10 CPI	$1195.00	$750.00
BCOKISER2KBF	9600 baud with 2K Serial Buffer upgrade with X-on Y-off		$159.00
BCOKIGRAPH	High Resolution Graphics Prom		$99.00

CALL FOR THE NEW MICROLINE 84

MX80 — EPSON NEED WE SAY MORE?

BCEPNMX80	Tractor Feed 17 lbs	$645.00	$450.00

PRINTER INTERFACES - MICROBYTE

RS232 Serial Conversion for MX80

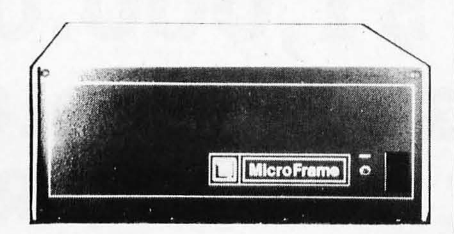
BCMBSSEI1	A & T	$55.00

Apple Centronics 8 bit parallel interface for Centronics, Epson & OKIDATA printers

BCMBSAEI1	A & T	$55.00
BCMBSAEC1	Cable for above	$14.95

Printer interfaces & cables sold only with printer purchase

S-100 MAINFRAMES



S-100 MICROFRAME - TEI

110V 60HZ CVT Mainframes, the best money can buy!
12 Slot ±8V 17A±16V @ 2A
22 Slot ±8V @ 30A± 16V @ 4A

PART NO.		LIST PRICE	OUR PRICE 1-9	OUR PRICE 10-24
BCTEIMCS 112	12 Slot Desk	$685.00	$615.00	$570.00
BCTEIMCS 122	22 Slot Desk	$825.00	$760.00	$705.00
BCTEIRM 12	12 Slot Rackmount	$725.00	$720.00	$619.00
BCTEIRM 22	22 Slot Rackmount	$875.00	$850.00	$750.00

Shipping Weight: On 12 Slot Mainframe 45 lbs.
On 22 Slot Mainframes 55 lbs.

TEI S-100 FRAMES 3 - 5" DISK CUTOUTS

±8V @ 17±16V @ 1.2A, Internal Cables

			1-9	10-24
BCTEITF12	12 Slot desk	$675.00	$625.00	$580.00
BCTEIRF12	12 Slot Rackmount	$795.00	$715.00	$665.00

Shipping Weight: On 12 Slot Desk 40 lbs.
On 12 Slot Rackmount 45 lbs.

DUAL 8" DISK DRIVE CHASSIS - TEI

For Shugart 800/801R or 850/851R with internal power cables provided
+24V @ 1.5A+5V @ 1.0A - 5V @ .25A

			1-9	10-24
BCTEBCFDO	Desk Top	$535.00	$485.00	$455.00
BCTEIRFDO	Rack Mount	$720.00	$670.00	$630.00
BCPDBDFDOS1	DFDO with 1 Shugart 801R			$$970.00
BCPDBDFDOS2	DFDO with 2 Shugart 801Rs			$1375.00
BCPDBRFDOS1	RFDO with 1 Shugart 801R			$1095.00
BCPDBRFDOS2	RFDO with 2 Shugart 801Rs			$1495.00
BCPRI50PGCE2	Internal Data Cable .50 pin plug connector to 2 Card Edge			$34.95

Due to UPS shipping regulations, disk drives will be shipped separately from the cabinet. Don't forget to include shipping for each drive. (Shipping Weight, 16 lbs each.)

CALL FOR NEW TEI PRICES MARCH 1st

S-100 MAINFRAME - GODBOUT

110V 60HZ CVT Mainframe uses famous 20 slot GODBOUT Motherboard. 55 lbs.

BCGBTENC20RM	20 Slot Rack Mount	$895.00	$825.00
BCGBTENC20DK	20 Slot Desk Top	$825.00	$760.00

S-100 MAINFRAME - CCS

12-slot motherboard with removable termination card

BCCCS220001	Office Cream	35 lbs	$575.00	$535.00
BCCCS220002	Blue	35 lbs	$575.00	$535.00

SOFTWARE - MICROPRO

All software is supplied on 8" Single Density IBM 3740 CP/M Compatable Diskettes

WORDSTAR

Screen-Oriented, integrated word processing system specifically designed for non-technical personnel

BCMPRWRDSTA1 $495.00 **$300.00**

MAIL MERGE WORD STAR OPTION

Powerful file merging tool

BCMPRMLMRGA1(Requires Word Star 2.1 or later)$250.00 **$100.00**

SPELLSTAR WORD STAR OPTION

One Step "Proofreader" with compressed 20,000 word dictionary and user-created supplemental dictionaries

BCMPRSPLSTA1 (Requires Word Star 3.0 or later) $250.00 **$150.00**

SUPERSORT

Sophisticated program that will select and re-arrange variable length information from data files

BCMPRSPRSRA1 $250.00 **$150.00**

CALC STAR

Sophisticated, easy-to-use, electronic spread sheet and financial planner

BCMPRCLCSTA1 $295.00 **$200.00**

DATA STAR

Office-Oriented Data Entry, retrival, and updating system

BCMPRDATSTA1 $350.00 **$200.00**

FLOPPY DISC DRIVES

Tandon TM-800 Thinline is exactly half the size of conventional 8" floppy disk drives.

ONE

Exactly one-half the height of any other model.
Propietary, high-resolution, read-write heads patented by Tandon
D.C. only operation - no A.C. required
Industry standard interface.
Three millisecond track-to-track access time 9 lbs.

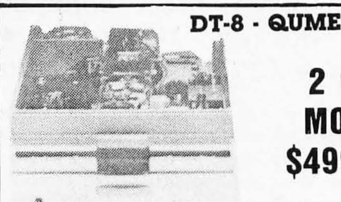
BCTNDTM8481	Single Sided	$495.00	2 or more	$470.00
BCTNDTM8482	Double Sided	$625.00	2 or more	$600.00
BCTNDTM8M	Manual - not included with drive			$ 10.00

80IR - SHUGART

Single sided double density most popular 8" drive

BCSHU80IR	$425.00 ea or 2 or more (16 lbs) for	$395.00 ea.
BCSHUSA80IRM	Manual for 80IR drives	$ 10.00

DT-8 - QUME



2 OR MORE $499.00

Data track 8 double sided, double density 8"

BCQMEDT8	Sh. Wt. 16 lbs	$525.00 ea.

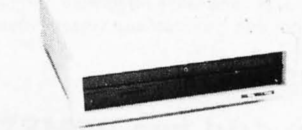
2 or more $499.00 each

BCQMEDT8M	Manual for DT-8	$ 10.00

5¼" DRIVES - TANDON

BCTNDTM1001	Single Sided, 250KB (5 lbs)	$310.00
BCTNDTM1002	Double Sided, 500KB	$370.00
BCTNDTM1003	Single Sided, 500KB	$375.00
BCTNDTM1004	Double Sided, 1000KB	$495.00
BCTNDTM5M	Manual, not included with drive	$ 10.00

DISK CABINETS



V-100 - VISTA

- Desk or rack mountable • Internal power and data cables
- Drives pull out for easy service and maintenance

BCVISV100	Disk Drive Cabinet (43 lbs)	$495.00	$449.00

SINGLE 8" - Q.T.

Single 8" cabinet with power supply

BCQTCDDC8	(22 lbs)	$249.00	$225.00

DUAL 8" - Q.T.

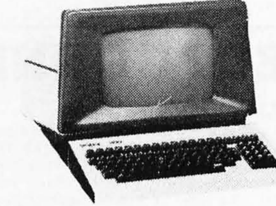
Dual 8' cabinet with power supply

BCQTCDDC88	(24)	$395.00	$349.00

5" CABINETS - VISTA

BCVIS 9801	Single 5" with P.S.	$75.00
BCVIS 9802	Dual 5" with P.S.	$95.00

TERMINALS



VT200 — VISUAL TECHNOLOGY

THE MOST RELIABLE TERMINAL WE'VE EVER USED!

Detachable keyboard, RS232C or 20MA interface, 110 to 19200 baud, 12" non glare 80 x 24 display, RS232 Aux. port and composite video out.

BCVSL200 Shipping Weight 55 lbs. **$995.00**

VIEWPOINT — ADDS

Detachable keyboard, RS232 interface and auxiliary port, 80 x 24 display, tiltable screen

BCADDVWPR Shipping Weight 40 lbs **SALE $599.00**

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PRIORITY ONE ELECTRONICS



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PRIORITY ONE ELECTRONICS

ONE

SAVE $1,000.00 ON

2.4 MEGA-BYTE S-100 DUAL 8" DISK COMPUTER SYSTEM

California Computer Systems

HERE'S WHAT YOU GET:
2210 MICROCOMPUTER SYSTEM

• 2 or 4 MHZ operation • Z-80 CPU • 65,536 bytes of dynamic RAM • RS-232-C serial port • Accepts 8" and 5¼" floppy disk drives • 12-slot, cream colored mainframe • Internal cabling installed • CP/M 2.2 (on diskette) Operating System

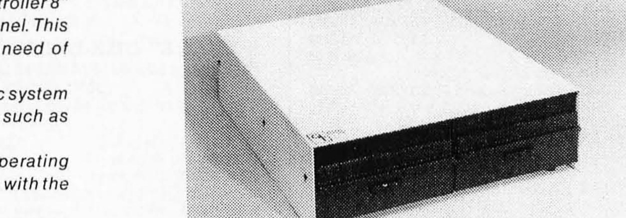
The Model 2210 Computer System is a Z-80 based system containing 65,536 bytes of dynamic RAM memory and floppy disk controller mounted in a 12 slot mainframe. The system is ideally suited for applications where user defined peripheral devices are to be used and a high degree of system flexibility and expandability is desirable.

The system components are the Models 2810 CPU, 2065 64K Byte Memory Module, 2422 Floppy Disk Controller and 2200 Mainframe. Also included in the system are internal cables interconnecting the DPU serial channel, disk controller 8" disk channel and disk controller 5¼" disk channel to the mainframe back panel. This permits connecting user peripherals directly to the system without the need of opening the mainframe.

Of the 12 slots available in the mainframe, only three are used for the basic system components. 9 slots are available for user options or other CCS products such as memory (expandable up to 512K bytes (serial and parallel I/O boards).

System software is provided using the CCS version of the CP/M Operating System, Version 2.2. The system is totally linked to permit auto-boot start-up with the CP/M on diskette.

The system is completely integrated and tested prior to shipment from CCS to assure proper configuration and system integrity.



BCCCS221001 **$2350.00**

We add two REMEX 4000 Double Density, Double Sided 3ms 8" drives and a QTCDDC88 Dual 8" disk enclosure with power supply data cable and documentation

SALE PRICE **$2930.00**

This is a complete system, just add a terminal

ORDER PART NO BCPDBCCSSA
INCLUDE $30.00 FOR SHIPPING



IF THAT'S NOT A GOOD ENOUGH DEAL FOR YOU, WE WILL SELL YOU THE BCOKIDAT82AT FOR $475.00 OR THE BCOKIDAT83AT FOR $700.00 WHEN YOU BUY THIS SYSTEM AT THE SAME TIME!



DIRECT CONNECT MODEM PRICE BREAKTHROUGH!

THE SIGNALMAN MK 1

Meet the direct-connect SIGNALMAN MK1 ... the smallest, lightest, most compact modem available today. Its long life 9 volt self-contained battery and exclusive audible Carrier Detect Signal allows you to install the SIGNALMAN anywhere ... out of he way, and out of sight. Now, there is no need for messy cables, and no need to look at an LED to verify carrier.

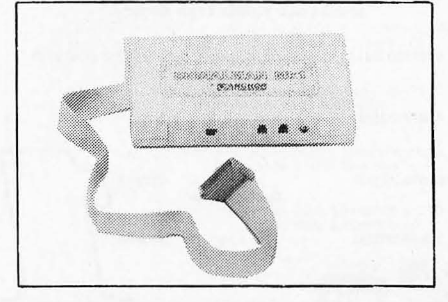
Anchor's SIGNALMAN has been designed for transmitting both voice and data signals over all common telephone lines. And when you're in the data position, your SIGNALMAN automatically changes from ORIGINATE to ANSWER and back again as the need arises — ending all that confusion.

Your SIGNALMAN is fuly compatible with all BELL 103 modems — putting your computer in instant communications with thousands of other computers.

Anchor Automation has taken the FUSS out of communications. For business or fun, SIGNALMAN is the ideal modem.

PRODUCT FEATURES

- Direct Connect Modem
- Built-in RS232C Cable and Connector
- Self-contained 9V Battery — Wall plug transformer available.
- Audible carrier detect signal
- Automatic mode selection
- Talk/Data switch
- CONNECTS IN SERIES WITH MODULAR *HANDSET* JACK ON TELEPHONE
- Complete with RS232C and Modular Handset Cables, eliminates need to buy cables — save $20.00-$30.00, assures correct fit.



- Uses low cost 9V battery. Eliminates unsightly cords and need for "another"
- AC outlet. Optional plug-in transformer available.
- Audio Transducer eliminates need to view LED to confirm connection — can be placed anywhere (velcro tape provided).
- Advanced IC Circuitry eliminates confusion of who is originator — ends need to manually switch from Originate to Answer and Vice/Versa.
- Permits you to listen/talk on phone or switch to data communications mode.
- Permits you to communicate with most other computer networks.
- Small size, light weight permits you to install the SIGNALMAN anywhere.
- Lowest priced modem available.

ANCHOR AUTOMATION **$129.00**

Circle 318 on inquiry card.

RS232C SPECIFICATIONS

Data Format: Serial, binary, asynchronous. **Operate Mode:** Manual dial, Automatic ANSW/ORIG selection. **Data Rate:** 0 to 300 bps, full duplex. **Modulation:** Frequency shift keyed (FSK). **Line Interface:** Direct Conect. **Data Interface:** RS232C, Cable to Computer Built-In.

Transmit Frequency:

	ORIG	ANSW
MARK	1270 Hz	2225 Hz
SPACE	1070 Hz	2025 Hz

Transmit Frequency Accuracy: 0.1%. **Transmit Level:** -12dbm.

Receive Frequency

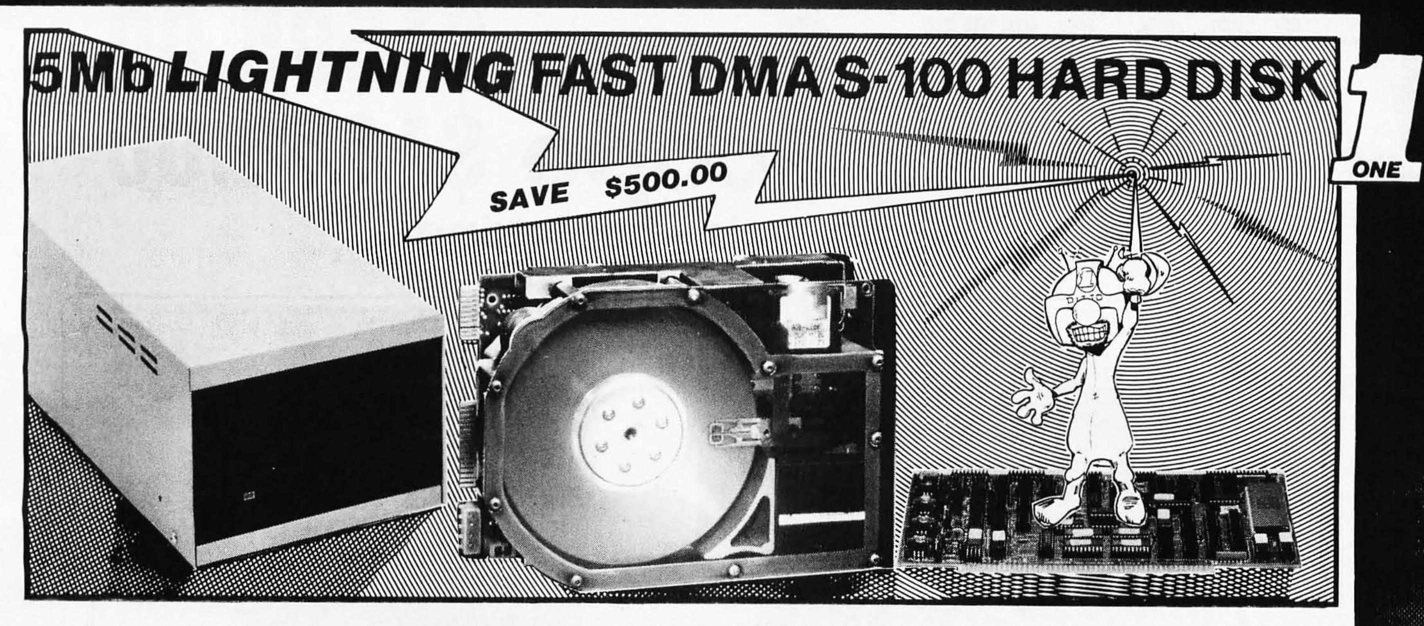
	ORIG	ANSW
MARK	2225 Hz	1270 Hz
SPACE	2025 Hz	1070 Hz

Carrier Detect Threshold: -44 dbm, plus or minus 2 dbm (ORIG). / -46 dbm, plus or minus 2 dbm (ANSW). **Carrier Detect Indicator:** Audible Tone. **Power Requirement:** Self-Contained — 9V Transistor Battery* / 110 VAC Through Adapter*. **Mechanical:** 8" x 4" x 1"
*Not Included

BCANCMK1 **$129.00**



HARD DISK FOR LESS THAN FLOPPIES



DISCUS M5 by MORROW DESIGNS

PRIORITY ONE ELECTRONICS **INTRODUCTORY PRICE: $1995.00**

LIST PRICE: $2495.00

PRIORITY 1 ELECTRONICS is pleased to announce Morrow Designs' DISCUS M5, the lowest cost 5 megabyte Winchester sub-system and the fastest. Now you can afford a hard disk for the price of floppies. Morrow Designs is the largest supplier of hard disk sub-systems to the S-100 market. With the new DMA Hard Disk Controller and the ST506 mini-Winchester drive, Morrow has attained speeds over 600,000 bytes per second.

As with all Morrow Designs' systems, Morrow delivers it complete. Drive, controller, cabinet, power supply, fan, transformer, cables, *CP/M 2.2*™ operating system, *Microsoft*™ Basic 80 and a ninety day warranty.

The DISCUS M5 regularly sells for $2495.00. *Priority 1 Electronics* is proud to offer the DISCUS M5 for a limited time at only $1995.00. Winchester speed, 5Mb capacity and reliability for only $1995.00. Three additional drives may be daisy-chained to the controller for future expansion. Perfect to back up each other at the end of each day. Takes seconds, is more reliable than tape and with the outside lock can be unplugged and removed (after the locking screw has been put in place.)

A few facts about the ST506 drive which is being used in the Discus M5:

Key Features

- Storage Capacity of 6.38 megabytes unformatted, 5.0 megabytes formatted as shipped
- Winchester design reliability, 9.5 gram head load force, 19 micro-inch flying height
- Same physical size and mounting as the minifloppy
- Same DC voltages as the minifloppy
- Band actuator and stepper motor head positioning
- 5.0 megabit/second transfer rate
- Same track capacity as a double density 8 inch floppy
- 170 millisecond random average access time, reduceable to 95 ms via a simple software algorithm

This is the hard disk controller that the S-100 bus has been waiting for. Please allow us to introduce you!

A few interesting facts

- The only single S-100 DMA Hard disk controller board on the market today
- Fully compatable with high speed 6MHz and 8 MHz CPUs of today and tomorrow
- DMA bus arbitration as outlined by the IEEE 696 standard
- Controls 1 to 4 soft sectored Winchester drives
- Supports both 5¼" and 8" drives
- ST506 or SA 1000 interface compatable
- Variable sector length (256, 512, 1024, or 2048 byte sectors)
- Automatic CRC generation and checking
- Addresses 1 to 16 heads
- Addresses an infinite number of tracks
- Contains its own on-board microprocessor
- 24-bit address burst DMA transfers
- Channel driven
- All disk driver routines resident on the controller
- Variable format
- No buffering required
- Maximum transfer rate 5,000,000 bits per second

Pure Speed

The speed of this Winchester controller is enhanced by Morrow's channel driven concept. This DMA hard disk controller (DMAHDC) picks up its commands from the host processor via memory on the system bus. The host processor writes commands into memory and then picks them up during DMA cycles from this memory. The channel, commands and transfers may be located anywhere in the 24-bit address range. At the completion of the command, the controller returns appropriate status and can generate an interrupt. Commands may be chained together by the CPU to allow the controller to execute many commands in succession, generating an interrupt at the end of each command and/or at the end of the completed command chain.

Communications

An imbedded microprocessor enables the user to easily communicate with this intelligent device. All low level disk drive routines are resident on the controller itself.

These include:

format
seek
read a header
read a sector
write a sector
return status
set DMA address
set channel address

Circle 318 on inquiry card.

Variable sector lengths are available. On Morrow Designs system products 512 byte sector lengths are standard. This is being done to maximize the capacities available on current drive units but may be varied by independent system integrators when desired.

The DMAHDC has been designed for expansion. One to four drives can be attached directly and controlled. One to sixteen drive heads may be addressed. Any number of tracks may be specified during the seek routine by specifying one to two hundred and fity-six tracks one or more times. Each of the expansion abilities prepare the user to upgrade his system as technology advances to additional platters and tracks.

The controller has no peer today in the S-100 bus market.

Systems interfaced:

1. North Star
2. Cromemco
3. Vector Graphics
4. Dynabyte
5. Micromation
6. Exidy
7. Imsai
8. Sol
9. California Computer
10. Godbout
11. Ithaca Intersystem

Look to Morrow for answers!

Look to PRIORITY 1 for the best price!

Priority 1 Electronics, as the world's largest stocking distributor of Morrow Designs' products committed to buy an entire production run of DISCUS M5 sub-systems so we can offer them at a special introductory low price. The DISCUS M5 is a good buy at the list price of $2495.00. The DISCUS M5 is an *excellent* value at our introductory low price of:

$1995.00

ORDER PART NO. **BCMDSDMAM5**



ORDER TOLL FREE (800) 423-5922









Include $10.00 for UPS Ground Shipping

Sale prices are for prepaid orders only. Orders on open account will be accepted at $2250.00 each.

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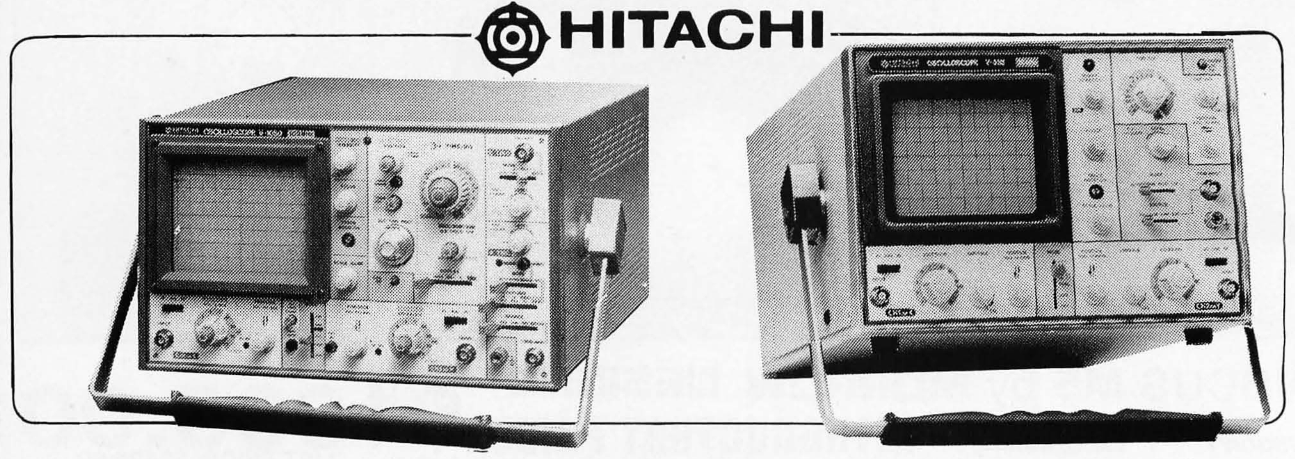
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COMPARE HITACHI SCOPES TO ANY OTHER

100 MHz Scope $1595.00
50 MHz Scope $1250.00

. . . and we're not joking!

HITACHI



No one can match the features or performance at our
MARKET-SHATTERING PRICES!

Buy with confidence from the nation's largest Hitachi distributor.

BCHITV1050 100 MHz, List $2375.00

Sale $1595.00

BCHITV550B 50 MHz, List $1745.00

Sale $1250.00

- *6" square CRT with internal graticule (illuminated scale)*
- *High sensitivity; 1mV/div. (10 MHz) V550B*
- *High sensitivity; .5mv/div. (10 MHz) V1050*
- *Automatic focus eliminates lag*
- *Trace rotation for easily adjusting brightline inclination caused by terrestial magnetism*
- *Third Channel Display (Trigger View) V550B*
- *Fourth Channel Display (Trigger View) V1050*
- *X-Y Operation Convenient for observation of two types of waves*
- *Delayed sweep permits 1,000 x magnification*
- *Variable Hold-off circuitry facilitates pulse measurement*
- *Single Sweep capability*
- *10 x sweep magnification facilitates precision measurement*
- *Delayed sweep jitter held below 1/20,000*
- *2 probes and cover included*
- *2 year warranty*

BCHITV352 35 MHz, List $1150.00

Sale $795.00

BCHITV202 20 MHz, List $850.00

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- *6" Square CRT with internal graticule (illuminated scale)*
- *High-accuracy voltage axis and time axis set at ±3% (certified at 10° to 34° C)*
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Until now, if you wanted a 50MHz or 100MHz dual trace oscilloscope of uncompromising quality, there was only one choice. Now there is a second...outstanding new delay sweep with an established name — the Hitachi V550B and the V1050.

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HITACHI Oscilloscopes are innovative oscilloscopes designed and manufactured by Hitachi Denshi Ltd. The wide experience gained by HITACHI electronic specialists in producing oscilloscopes has resulted in this line of modern oscilloscopes featuring wider band width, more compact design and light weight. Through adopting circuitry with linear IC's and logic IC's plus modern manufacturing techniques, including automatic component-insertion machines. These oscilloscopes offer increased stability, improved reliability, excellent performance and enhanced operating ease.

The panel layout is designed to create maximum operating ease by considering measuring processes and operation frequency. The layout is divided into three blocks according to respective functions identified by different colors. This convenience-oriented design for users improves daily controllability and drastically reduces operating errors.

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Circle 319 on inquiry c

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ISOLATES SENSITIVE AND VALUABLE EQUIPMENT FROM: Equipment interaction - Damaging High Voltage Spikes - AC line noise and hash.
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VOLTAGE TRANSIENT SPIKE PROTECTION: 2000 A peak for up to 6 Sec duration spikes. 1000A, 8/20 Sec protection from repeated spikes.
LOAD HANDLING: 1875 W max. total load; 15A per socket.
INPUT: 125 VAC, 15 amps; standard 3-prong plug.

Three common outlets built-in circuit breaker, pilot light, hang-up bracket and a 6 foot cord.

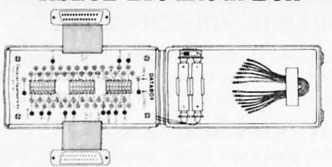
		LIST PRICE	OUR PRICE
BCGOFIBAR3	SH. WT. 3 lbs.	$59.95	**$39.95**

IBAR 46 - Four independently isolated outlets. Built-in 15A circuit breaker, pilot light, switch, and 6 foot cord.
BCGOFIBAR46 SH. WT. 4 lbs. $79.95 **$49.95**

IBAR 86 - 8 outlets, grouped to form 4 independently isolated sets of two. Built in 15A circuit breaker, on/off switch, pilot light.
BCGOFIBAR86 SH. WT. 5 lbs. $84.95 **$54.95**

IBAR 9RM - Eight rear-mounted outlets grouped to form four independently isolated sets of two, plus one non-isolated convenience outlet on front face. 19" rack mount cabinet. Built in 15A circuit breaker, pilot light, on/off switch, and 6 foot cord.
BCGOFIBAR9RM SH. WT. 6 lbs. $99.95 **$74.95**

RS232 Breakout Box



A must for every technician, repair man or systems integrator

The Breakout Box contains 24 Dual-In-Line Switches which allow any of the interface signals (except Pin 1, which is not used) to be interrupted. The switches are located in the center of the main control panel. A 25 way female connector for connecting the box to the DTE is fitted to the left hand side via a ribbon cable and a 25 way male connector for connection to the DCE is similarly connected to the right hand side.

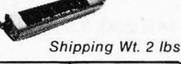
DTE and DCE interface connection pins are located on both sides of the Dual-In-Line switches. Using the jumpers supplied, these pins permit monitoring of any of the interface lines with either or both the positive and negative test indicators on the front panel. These pins also permit cross-patching or the connection of an external test meter or oscilloscope.

The Breakout Box contains indicators which monitor the following signals:

Pin	Function
2	Transmitted Data
3	Received Data
4	Request to Send
5	Ready for Sending (clear to send)
6	Data Set Ready
8	Data Channel Received Line Signal Detector
15	Transmitter Signal Element Timing
17	Receiver Signal Element Timing
20	Connect Data Set to Line/Data Terminal Ready
21	Signal Quality
22	Ring Indicator
25	Busy

Databox is contained in a tough plastic case and is powered by two, 1.5 volt penlight batteries. No power is consumed by the tester when not in use. Dimensions: 2.9" x 5.55" x 1.45". Weight: 10 ounces, with batteries.
BCDNW232BOX $199.00 **$159.00**

GLOBAL SPECIALTIES LOGIC PROBES



SPECIFICATIONS *Shipping Wt. 2 lbs*

MODEL	LP1	LP2	LP3
Response	50 ns. 80 ns single-shot event, 10MHz pulse train	300 ns; 1.5MHz pulse train	6 ns typical, tested at 10 ns. 70MHz pulse train
Pulse Mode	High Speed Train or Single Event		

Part No.	Description	List Price	Our Price
BC05GSCLP1	Standard 10MHz w/Memory	$50.00	**$45.00**
BC05GSCLP2	Economy 1.5MHz	$32.00	**$30.00**
BC05GSCLP3	High Speed 50MHz w/Memory	$77.00	**$69.00**
BCGSCDP1	High speed Digital Pulser. 100 PPS or single-shot	$83.00	**$76.00**
BCGSCLTC1	LP1, DP1 and LM1 in molded case	$240.00	**$220.00**
BCGSCLTC2	LP3, DP1 and LM1 in molded case	$270.00	**$245.00**

MICROCOMPUTER PRODUCTS

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PART NO.	PRICE
BC4116AC20	8/$20.00
BC2016P3	8/$72.00
BC2114N3L	8/$28.00
BC5257N3L	8/$50.00
BC2732	8/$120.00
BC2716	8/$50.00
BC2708	8/$20.00

Z80 SERIES

BCZ80A	$14.95
BCZ80AP10	$14.95
BCZ80ACTC	$13.95
BCZ80ADMA	$45.00
BCZ80AS100	$59.95
BCZ80AS101	$59.95
BCZ80AS102	$59.95

UARTS

BCAY51013A	$5.95
BCTR1602B	$5.95
BCTR1863	$6.95
BCIM6402	$7.95

8080 SERIES

PART NO.	PRICE
BCINS 8080A	$5.50
BCINS 8085A	$19.95
BCDP8212N	$2.95
BCDP8214N	$5.25
BCDP8216N	$2.95
BCDP8224N	$3.25
BCDP8224-4N	$9.95
BCDP8226N	$3.50
BCDP8228N	$5.55
BCDP8238N	$5.55
BCINS8250N	$15.00
BCINS8251N	$7.50
BCINS8253N	$17.95
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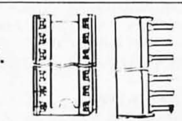
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BCKTH1304	Soft Carrying Case & Stand(handhelds)	**$ 10.00**
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BCKTH179A	4½ Digit, LED Dispay, TRMS	**$359.00**
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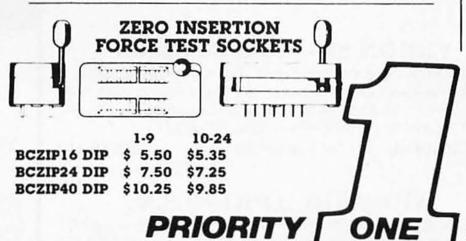
See pp. 42-43 of our Engineering Selection Guide in the November **BYTE** for a complete list of specifications and accessories.

SPECIAL PURCHASE
GOLD
16 PIN LOW PROFILE IC. C95 SOCKETS



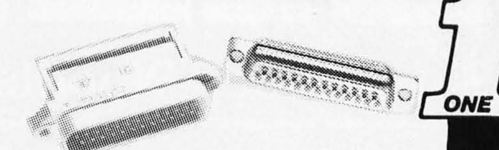
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	1-9	10-24
BCZIP16 DIP	$ 5.50	$5.35
BCZIP24 DIP	$ 7.50	$7.25
BCZIP40 DIP	$10.25	$9.85

D-SUBMINIATURE CONNECTORS



INSULATION DISPLACEMENT TYPE

P = Plug, Male Type - S = Socket, Female Type - C = *Cover Hood*

PART NO.	NO. OF PINS	1-9	10-24	25-99	100-249
BCIDCDE9P	9	4.20	4.00	3.60	3.20
BCIDCDE9S	9	4.50	4.20	3.80	3.40
BCIDCDE9C	9	1.25	1.10	1.00	.95
BCIDCDA15P	15	4.35	4.20	3.75	3.40
BCIDCDA15S	15	5.00	4.85	4.35	3.90
BCIDCDA15C	15	1.40	1.25	1.10	.95
BCIDCDB25P	25	6.25	6.00	5.20	4.70
BCIDCDB25S	25	6.60	6.35	5.60	5.00
BCIDCDB25C	25	1.60	1.50	1.35	1.20
BCIDCDC37P	37	8.80	8.00	7.20	6.40
BCIDCDC37S	37	11.00	10.25	9.20	8.20
BCIDCDC37C	37	2.25	2.20	1.80	1.60

SOLDER TYPE

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
BCCNDDE9P	9 Pin Male	$2.10	$1.90	$1.70
BCCNDDE9S	9 Pin Female	$2.70	$2.40	$2.10
BCCNDDE9C	9 Pin Cover	$1.50	$1.25	$1.10
BCCNDDA15P	15 Pin Male	$2.75	$2.45	$2.15
BCCNDDA15S	15 Pin Female	$3.95	$3.60	$3.20
BCCNDDA15C	15 Pin Cover	$1.50	$1.30	$1.10
BCCNDDB25P	**25 Pin Male**	$3.00	$2.75	$2.25
★**BCCNDDB25P** 100 pcs at **$1.95 ea** ★				
BCCNDDB25S	**25 Pin Female**	$4.00	$3.75	$3.00
★ **BCCNDDB25S** 100 pcs at **$2.95 ea** ★				
BCCNDDB51226	**2 Pc. Black Hood**	$1.90	$1.65	$1.45
BCCNDDB51212	**1 Pc. Grey Hood**	$1.60	$1.45	$1.30
BCCNDP25H	**2 Pc. Grey Hood**	$1.50	$1.25	$1.10
BCCNDDC37P	37 Pin Male	$5.80	$5.10	$4.45
BCCNDDC37S	37 Pin Female	$8.70	$7.70	$6.70
BCCNDDC37C	37 Pin Cover	$1.80	$1.55	$1.30
BCCNDDD50P	50 Pin Male	$8.75	$7.75	$6.70
BCCNDDD50S	50 Pin Female	$11.65	$10.25	$8.90
BCCNDDD50C	50 Pin Cover	$2.00	$1.80	$1.60
BCCNDD20418	Hardware Set 2 Pr. RS232, DB25P, EIA	$1.00	$ .80	$ .70
BCCNDRS2328F	Class 1 Cable 8 Con. 8 Ft	$19.95	$17.95	$15.95
BCCND5730360	Cent. 700 Series/Epson Printer Conn.	$9.00	$7.50	$6.00
BCIDC5730360	IDC Version of Above	$9.95	$9.00	$8.00



THE STAR MODEM from PRENTICE
FEATURE
FITS GTE HANDSETS!
1 YEAR WARRANTY

EXCLUSIVE ACOUSTIC CHAMBERS:
The exclusive triple seal of Prentice's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world.

SELF TEST:
The self test feature on the STAR allows the user to verify total operation of the acoustic modem by using the terminal in the full duplex mode. No need for remote assistance in diagnosing terminal or modem problems.

SPECIFICATIONS:
- **Data Rate:** 0 to 300 baud
- **Compatability:** Bell 103 and 113: CCITT
- **Frequency Stability:** ±0.3 percent. Crystal controlled
- **Receiver Sensitivity:** -50 dBm ON. -53 dBm OFF
- **Modulation:** Frequency shift keyed (FSK)
- **Carrier Detect Delay:** 1.2 seconds ON; 120 sec OFF
- **EIA Terminal Interface:** Compatable with RS232 specs.
- **Teletype Interface:** 20 milliampere current loop
- **International (CCITT) frequencies available.**
- **Switches:** Originate/Off/Answer; Full duplex/Test/-Half Duplex
- **Indicators:** Transmit Data, Receive Data, Carrier Ready. Test.

PART NO.	DESCRIPTION	LIST PRICE	SALE PRICE
BCPRNSTAR	RS232, TTL 200 Ma Current Loop	$199.00	**$129.00**

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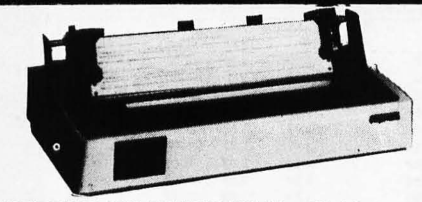
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Printers



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Microline 82A 80/132 column, 120 CPS, 9 x 9 dot matrix, friction feed, pin feed, adjustable tractor feed (removable), handles 4 part forms up to 9.5" wide, rear & bottom feed, paper tear bar, 100% duty cycle/200,000,000 character print head, bi-directional/logic seeking, both serial & parallel interfaces included, front panel switch & program control of 10 different form lengths, uses inexpensive spool type ribbons, double width & condensed characters, true lower case descenders & graphics

PRM-43082 *with FREE tractor* $544.95

Microline 83A 132/232 column, 120 CPS, handles forms up to 15" wide, plus all the features of the 82A.

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Microline 84 132/232 column, 200 CPS, full dot graphics built in, handles forms up to 15" wide, plus all the features of the 83A.

PRM-43083 *with FREE tractor* ... $1249.95

PRA-27081 *Apple card* $39.95
PRA-27082 *Apple cable* $19.95
PRA-27087 *TRS-80 cable* $24.95
PRA-43081 *Hi speed 2K serial board* $169.95
PRA-43080 *Extra ribbons pkg. of 2* ... $9.95

INEXPENSIVE PRINTERS - Epson

MX-70 80 column, 80 CPS, 5 x 7 dot matrix, adjustable tractor feed, & graphics

PRM-27070 *List $459* $399.95

MX-80 80 column, 80 CPS, bi-directional/logic seeking printing, 9 x 9 dot matrix, adjustable tractor feed, & 64 graphics characters

PRM-27080 *List $645* $469.95

MX-80FT same as MX-80 with friction feed added.

PRM-27082 *List $745* $559.95

MX-100 132 column, correspondence quality, graphics, up to 15" paper, friction feed & adjustable tractor feed, 9 x 9 dot matrix, 80 CPS.

PRM-27100 *List $945* $759.95

PRA-27084 *Serial interface* $69.95
PRA-27088 *Serial intf & 2K buffer* .. $144.95
PRA-27081 *Apple card* $74.95
PRA-27082 *Apple cable* $22.95
PRA-27086 *IEEE 488 card* $52.95
PRA-27087 *TRS-80 cable* $32.95
PRA-27085 *Graftrax II* $95.00
PRA-27083 *Extra ribbon* $14.95

Modems

SMARTMODEM - Hayes

Sophisticated direct-connect auto-answer/auto-dial modem, touch-tone or pulse dialing, RS-232C interface, programmable

IOM-5400A *Smartmodem* $249.95
IOK-1500A *Hayes Chronograph* ... $199.95

CAT MODEMS - Novation

CAT 300 baud, acoustic, answer/orginate

IOM-5200A *List $189.95* $149.95

D-CAT 300 baud direct connect, answer/orginate

IOM-5201A *List $199.95* $169.95

AUTO-CAT Auto answer/orginate, direct connect

IOM-5230A *List $299.95* $239.95

Apple-CAT - Novation

Software selectable 1200 or 300 baud, direct connect, auto-answer/auto-dial, auxiliary 3-wire RS232C serial port for printer.

IOM-5232A *Save $50.00!!!* $325.00

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A2 Direct replacement for Apple Disk II, works with Apple II controller as first or second drive.

MSM-123101 *Micro Sci A2* $429.95

A40 40 track drive for Apple II. Improved storage capacity and speed over Apple Brand drives - requires Micro Sci controller.

IOD-2340A *Micro Sci A40* $399.95

A70 70 track drive for Apple II. Twice the storage capacity and three times faster than Apple Brand drives - requires Micro Sci controller

IOD-2370A *Micro Sci A70* $499.95

Micro Sci Controller Disk controller for up to two Micro Sci A40 or A70 disk drives, DOS 3.2, 3.3, Pascal, and Z-80 SoftCard compatible, includes utility disk and 40/70 track patch.

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80 column x 24 line video card for Apple II, 128 ASCII characters, upper and lower case, 9 x 10 dot matrix with 3 dot descenders, standard data media terminal control codes, CP/M Pascal & Fortran compatible, 50/60 Hz

IOV-2400A *Vista Vision 80* $375.00

AIO, ASIO, APIO - S.S.M.

Parallel & serial interface for your Apple (see Byte pg 11)

IOI-2050K *Par & Ser kit* $139.95
IOI-2050A *Par & Ser A & T* $169.95
IOI-2052K *Serial kit* $89.95
IOI-2052A *Serial A & T* $99.95
IOI-2054K *Parallel kit* $69.95
IOI-2054A *Parallel A & T* $89.95

CPS MULTICARD - Mtn. Computer

Three cards in one! Real time clock/calendar, serial interface, & parallel interface - all on one card.

IOX-2300A *A & T* $199.95

Single Board Computer

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CPS-30100K *KIT* $299.95
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CPK-50020A *A & T* $249.95

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VDC-801310 *13" Color I* $379.95
VDC-801320 *Color II* $895.00
IOV-2300A *DVM board for Apple* .. $199.95

Video Terminals

TELEVIDEO 910

Full featured - inexpensive terminal

VDT-901210 *List 795.00* $695.00

TELEVIDEO 950

VDT-901250 *List $1195.00* $995.00

AMBER SCREEN - Volker Craig

Detachable keyboard, amber on black display, 7 x 9 dot matrix, 10 program function keys, 14 key numeric pad, 12" non-glare screen, 50 to 19,200 baud, direct cursor control, auxiliary bi-directional serial port

VDT-351200 *List $795.00* $645.00

VIEWPOINT - ADDS

Detachable keyboard, serial RS232C interface, baud rates from 110 to 19,200, auxiliary serial output port, 24 x 80 display,

VDT-501210 *Sale Priced* $639.95

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FREE 1982 CATALOG

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S-100 CPU Boards

THE BIG Z* - Jade
2 or 4 MHz switchable Z-80 CPU with serial I/O, accomodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600*

CPU-30201K *Kit* $139.95
CPU-30201A *A & T* $189.95
CPU-30200B *Bare board* $35.00

2810 Z-80* CPU - Cal Comp Sys
2/4 MHz Z-80A CPU with RS-232C serial I/O port and on board MOSS 2.2 monitor PROM, front panel compatible*

CPU-30400A *A & T* $269.95

CB-2 Z-80 CPU - S.S.M.
2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.

CPU-30300K *Kit* $239.95
CPU-30300A *A & T* $299.95

S-100 PROM Boards

PROM-100 - SD Systems
2708, 2716, 2732 EPROM programmer w/software

MEM-99520K *Kit* $189.95
MEM-99520A *A & T* $249.95

PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer

MEM-99510K *Kit* $154.95
MEM-99510A *A & T* $219.95

EPROM BOARD - Jade
16K or 32K uses 2708's or 2716's, 1K boundary

MEM-16230K *Kit* $79.95
MEM-16230A *A & T* $119.95

S-100 Video Boards

VB-3 - S.S.M.
80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board input.

IOV-1095K *4 MHz kit* $349.95
IOV-1095A *4 MHz A & T* $439.95
IOV-1096K *80 x 48 upgrade* $39.95

VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O, and on-board Z-80A.*

IOV-1020A *A & T* $459.95

VIDEO BOARD - S.S.M.
64 characters x 16 lines, 128 x 48 matrix for graphics, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100.

IOV-1051K *Kit* $149.95
IOV-1051A *A & T* $219.95
IOV-1051B *Bare board* $34.95

S-100 Motherboards

ISO-BUS - Jade
Silent, simple, and on sale - a better motherboard

6 Slot (5¼" x 8⅝")

MBS-061B *Bare board* $19.95
MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95

12 Slot (9¾" x 8⅝")

MBS-121B *Bare board* $29.95
MBS-121K *Kit* $69.95
MBS-121A *A & T* $89.95

18 Slot (14½" x 8⅝")

MBS-181B *Bare board* $49.95
MBS-181K *Kit* $99.95
MBS-181A *A & T* $139.95

S-100 RAM Boards

MEMORY BANK - Jade
4 MHz, S-100, bank selectable, expandable from 16K to 64K

MEM-99730B *Bare Board* $49.95
MEM-99730K *Kit no RAM* $199.95
MEM-32731K *32K Kit* $239.95
MEM-64733K *64K Kit* $279.95
Assembled & Tested .... add $50.00

64K RAM - Calif Computer Sys
4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable, PHANTOM line allows memory overlay, 8080 / Z-80 / front panel compatible.

MEM-64565A *A & T* $575.00

64K STATIC RAM - Mem Merchant
64K static S-100 RAM card, 4-16K banks, up to 8MHz

MEM-64400A *A & T* $789.95

32K STATIC RAM - Jade
2 or 4 MHz expandable static RAM board uses 2114L's

MEM-16151K *16K 4 MHz kit* $169.95
MEM-32151K *32K 4 MHz kit* $299.95
Assembled & tested .... add $50.00

16K STATIC RAM - Mem Merchant
4 MHz 16K static RAM board, IEEE S-100, bank selectable, Phantom capability, addressable in 4K blocks, "disable-able" in 1K segments, extended addressing, low power

MEM-16171A *A & T* $164.95

S-100 Disk Controllers

DOUBLE-D - Jade
Double density controller with the inside track, on-board Z-80A, printer port, IEEE S-100, can function on an interrupt driven buss*

IOD-1200K *Kit* $299.95
IOD-1200A *A & T* $375.00
IOD-1200B *Bare board* $59.95

DOUBLE DENSITY - Cal Comp Sys
5¼" and 8" disk controller, single or double density, with on-board boot loader ROM, and free CP/M 2.2 and manual set.*

IOD-1300A *A & T* $374.95

S-100 I/O Boards

S.P.I.C. - Jade
Our new I/O card with 2 SIO's, 4 CTC's, and 1 PIO

IOI-1045K *2 CTC's, 1 SIO, 1 PIO* .. $179.95
IOI-1045A *A & T* $239.95
IOI-1046K *4 CTC's, 2 SIO's, 1 PIO* $219.95
IOI-1046A *A & T* $299.95
IOI-1045B *Bare board w/ manual* ... $49.95

I/O-4 - S.S.M.
2 serial I/O ports plus 2 parallel I/O ports

IOI-1010K *Kit* $179.95
IOI-1010A *A & T* $249.95
IOI-1010B *Bare board* $35.00

S-100 Mainframes

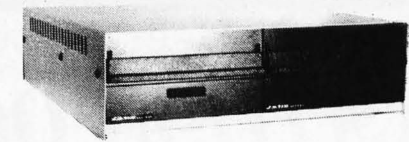
MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply

ENC-112105 *Kit* $329.95
ENC-112106 *A & T* $399.95

EPROM ERASER - Spectronics
Ultra-violet EPROM erasers

XME-3100A *With out timer* $69.50
XME-3101 *With timer* $94.50
XME-3200 *Economy Model* $39.95

Disk Drives



Handsome metal cabinet with proportionally balanced air flow system • Rugged dual drive power supply • Power cable kit • Power switch, line cord, fuse holder, cooling fan • Never-Mar rubber feet • All necessary hardware to mount 2-8" disk drives, power supply, and fan • Does not include signal cable

Dual 8" Subassembly Cabinet

END-000420 *Bare cabinet* $59.95
END-000421 *Cabinet kit* $225.00
END-000431 *A & T* $359.95

8" Disk Drive Subsystems
Single Sided, Double Density

END-000423 *Kit w/2 FD100-8Ds* . $924.95
END-000424 *A & T w/2 FD100-8Ds* $1124.95
END-000433 *Kit w/2 SA-801Rs* ... $999.95
END-000434 *A & T w/2 SA-801Rs* $1195.00

8" Disk Drive Subsystems
Double Sided, Double Density

END-000426 *Kit w/2 DT-8s* $1224.95
END-000427 *A & T w/2 DT-8s* ... $1424.95
END-000436 *Kit w/2 SA-851Rs* .. $1295.00
END-000437 *A & T w/2 SA-851Rs* $1495.00

5¼" Disk Drives

***Shugart SA400L** sngl-sided dbl-density 40 track*
MSM-104000 .. $234.95 ea 2 for **$224.95 ea**

***Shugart SA450** dbl-sided dbl-density 70 track*
MSM-104500 .. $349.95 ea 2 for **$329.95 ea**

***Qume DT-5** dbl-sided dbl-density 80 track*
MSM-750050 .. $359.95 ea 2 for **$349.95 ea**

***MPI B-51** sngl-sided dbl-density 40 track*
MSM-155100 .. $234.95 ea 2 for **$224.95 ea**

***MPI B-52** dbl-sided dbl-density 40 track*
MSM-155200 .. $344.95 ea 2 for **$334.95 ea**

***MPI B-91** sngl-sided dbl-density 77 track*
MSM-155300 .. $369.95 ea 2 for **$359.95 ea**

***MPI B-92** dbl-sided dbl-density 77 track*
MSM-155400 .. $469.95 ea 2 for **$459.95 ea**

8" Disk Drives

***Shugart SA801R** single-sided double-density*
MSF-10801R .. $394.95 ea 2 for **$389.95 ea**

***Shugart SA851R** double-sided double-density*
MSF-10851R .. $554.95 ea 2 for **$529.95 ea**

***Qume DT-8** double-sided double-density*
MSF-750080 .. $524.95 ea 2 for **$499.95 ea**

***Siemens FDD 100-8** sngl-sided dbl-density*
MSF-201120 .. $384.95 ea 2 for **$349.95 ea**

BUS PROBE - Jade
S-100 diagnostic analyzer board, dynamic visual display of all 96 IEEE S-100 signals, aids in real time analysis of faulty hardware and software

TSX-200B *Bare Board* $59.95
TSX-200K *Kit* $119.95
TSX-200A *A & T* $149.95

Circle 200 on inquiry card.

SD Systems ExpandoRAM III

256K RAM $879.95

Single User System

SBC-200, 64K ExpandoRAM II, Versafloppy II, CP/M 2.2

$1095.00

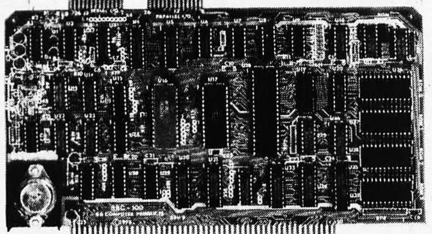
4 MHz Z-80A CPU, 64K RAM, serial I/O port, parallel I/O port, double-density disk controller, CP/M 2.2 disk and manuals, system monitor, control and diagnostic software.

Add $100.00 for upgrade to ExpandoRAM III 64K (expandable to 256K)

-All boards are assembled and tested-

SBC-200

2 or 4 MHz single board computer



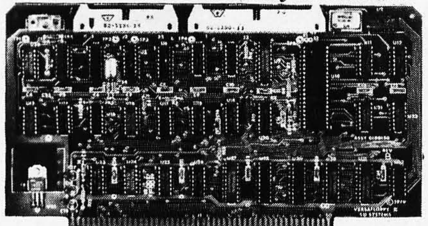
• S-100 bus compatible • Powerful 4MHz Z-80A CPU • Synchronous/asynchronous serial I/O port with RS-232 interface and software programmable baud rates up to 9600 baud • Parallel input and parallel output port • Four channel counter/timer • Four maskable, vectored interrupt inputs and a non-maskable interrupt • 1K of on-board RAM • Up to 32K of on-board ROM • System monitor PROM included

The SBC-200 is an excellent CPU board to base a microcomputer system around. With on-board RAM, ROM, and I/O, the SBC-200 allows you to build a powerful three-board system that has the same features found in most five-board microcomputers. The SBC-200 is compatible with both single-user and multi-user systems.

CPU-30200A *A & T with monitor* **$299.95**

Versafloppy II

5¼" & 8" double density controller



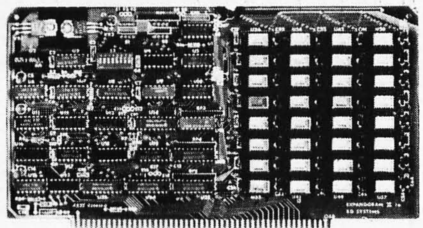
• S-100 bus compatible • IBM 3740 compatible soft sectored format • Controls single and double-sided drives, single or double density, 5¼" and 8" drives in any combination of four simultaneously • Drive select and side select circuitry • Analog phase-locked loop data seperator • Vectored interrupt operation optional • Standard CP/M 2.2 disk operating • Control/diagnostic software PROM included

The Versafloppy II is faster, more stable and more tolerant of bit shift and "jitter" than most controllers. All control and diagnostic software included.

IOD-1160A *A & T* **$359.95**
For CP/M 2.2 and manual set add **$99.95**

ExpandoRAM III

64K to 256K expandable RAM board



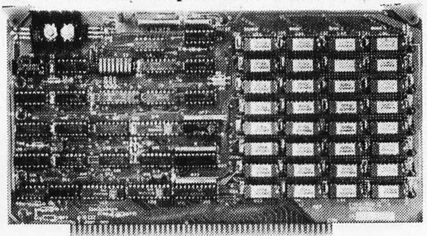
SD Systems has duplicated the famous reliability of their ExpandoRAM I and II boards in the new ExpandoRAM III, a board capable of containing 256K of high speed RAM. Utilizing the new 64K x 1 dymanic RAM chips, you can configure a memory of 64K, 128K, 192K, or 256K, all on one S-100 board. Memory address decoding is done by a programmed bipolar ROM so that the memory map may be dip-switch configured to work with either COSMOS/MPM-type systems or with OASIS-type systems.

Extensive application notes concerning how to operate the ExpandoRAM III with Cromemco, Intersystems, and other popular 4 MHz Z-80 systems are contained in the manual.

MEM-65064A	*64K A & T*	**$495.00**
MEM-65128A	*128K A & T*	**$639.95**
MEM-65192A	*192K A & T*	**$769.95**
MEM-65256A	*256K A & T*	**$879.95**

ExpandoRAM II

16K to 64K expandable RAM board



• S-100 bus compatible • Up to 4MHz operation • Expandable from 16K to 64K • Uses 16 x 1 4116 memory chips • Page mode operation allows up to 8 memory boards on the bus • Phantom output disable • Invisible on-board refresh

The ExpandoRAM II is compatible with most S-100 CPUs. When other SD System' series II boards are combined with the ExpandoRAM II, they create a microcomputer system with exceptional capabilities and features.

MEM-16630A	*16K A & T*	**$345.00**
MEM-32631A	*32K A & T*	**$365.00**
MEM-48632A	*48K A & T*	**$385.00**
MEM-64633A	*64K A & T*	**$399.95**

PROM-100

Versatile EPROM Programmer

• S-100 bus compatible • Programs 2708, 2758, 2716, 2732, 2516 EPROMs • DIP switch selection of EPROM type • 25 VDC programming pulse generated on-board • Very fast programming and verification • Zero insertion force socket • Programming software included on 8" diskette

MEM-99520K	*Kit w/software*	**$189.95**
MEM-99520A	*A & T w/software* ...	**$249.95**

Multi-User System

SBC-200, 256K ExpandoRAM III, Versafloppy II, MPC-4 COSMOS Multi-User Operating System, C BASIC II

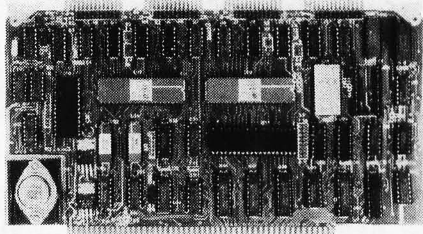
$1995.00

Two Z-80A CPUs (4 MHz), 256K RAM, 5 serial I/O ports with independently programmable baud rates and vectored interrupts, parallel input port, parallel output port, 8 counter/timer channels, real time clock, single and double sided/single or double density disk controller for 5¼" and 8" drives, up to 36K of on-board ROM, CP/M 2.2 compatible COSMOS interrupt driven multi-user disk operating system, allows up to 8 users to run independent jobs concurrently, C BASIC II, control and diagnostic software in PROM included.

-All boards are assembled and tested-

MPC-4

Intelligent communications interface



• Four buffered serial I/O ports • On-board Z-80A processor • Four CTC channels • Independently programmable baud rates • Vectored interrupt capability • Up to 4K of on-board PROM • Up to 2K of on-board RAM • On-board firmware

This is not just another four-port serial I/O board! The on-board processor and firmware provide sufficient intelligence to allow the MPC-4 to handle time consuming I/O tasks, rather than loading down your CPU. To increase overall efficiency, each serial channel has an 80 character input buffer and a 128 character output buffer. The on-board firmware can be modified to make the board SDLC or BISYNC compatible. In combination with SD's COSMOS operating system (which is included with the MPC-4), this board makes a perfect building block for a multi-user system.

IOI-1504A *A & T with COSMOS* .. **$495.00**

Place Orders Toll Free

Continental U.S. **800-421-5500**
Inside California **800-262-1710**

For Technical Inquires or Customer Service call:
213-973-7707

JADE
Computer Products

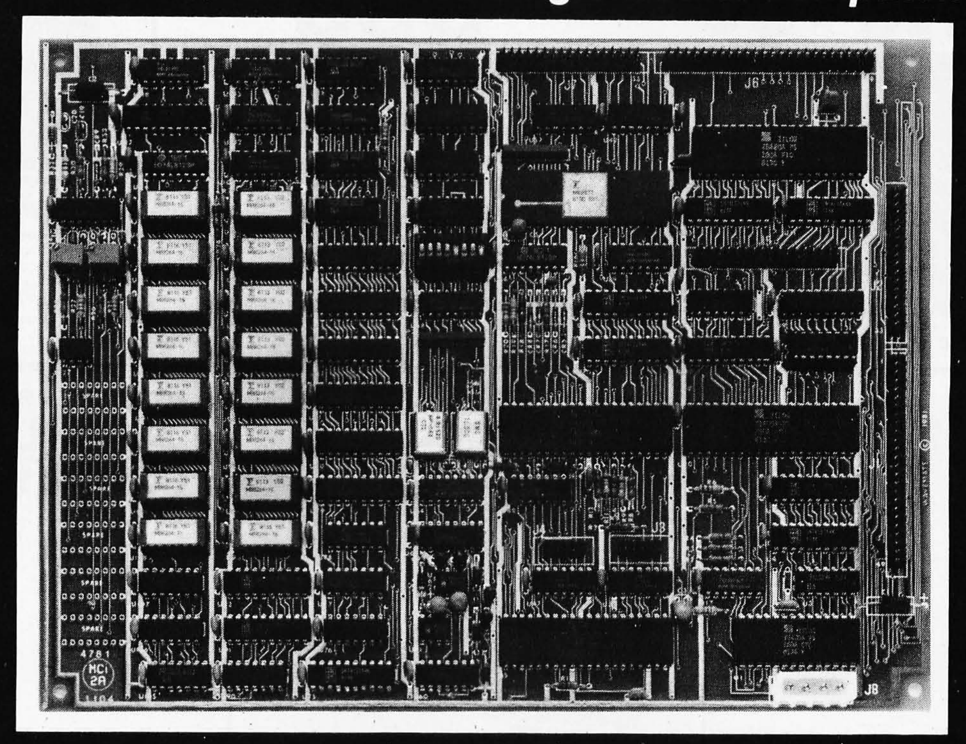
4901 W. Rosecrans, Hawthorne, Ca 90250

TERMS of SALE: Cash, checks, credit cards, or Purchase Orders from qualified firms and institutions. **Minimum Order $15.00.** California residents add 6% tax. Minimum shipping & handling charge $3.00. **Pricing & availibility subject to change**

Circle 201 on inquiry card.

THE WAVE MATE "BULLET – (SBC)" is the STATE-OF-THE-ART Single Board Computer.

Never before has there been so much technology contained on ONLY ONE Single Board Computer.



Standard size 8 x 10.7 inches

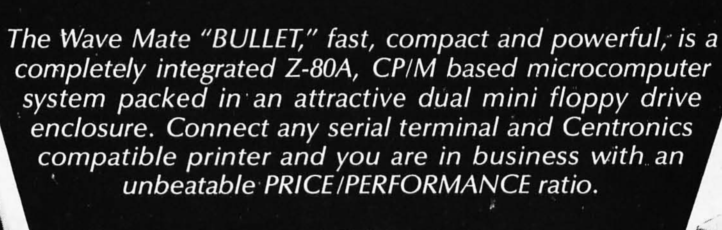
COMPARE THESE FEATURES:

- 4 MHz Z-80A CPU
- 128 K byte RAM with bank select
- Single/Double density floppy disk controller for both 5¼ inch and 8 inch drives
- DMA floppy disk operation with optional high speed RAM track buffer
- General purpose external DMA I/O
- 2 serial ports with transmission rates to 38.4 K baud with optional DMA operation
- Centronics printer port with optional DMA operation
- Hard disk interface with optional DMA operation
- Vectored interrupts
- Real time clock
- 5 volts only

THE WAVE MATE ENHANCED C-BIOS PROVIDES SEVERAL POWERFUL ADDITIONS TO THE INDUSTRY STANDARD OPERATING SYSTEM. THESE ARE AS FOLLOWS:

- Optimized disk track interlacing
- Full disk track buffering
- Keyboard type-ahead
- Optional multi-user operation
- Disk write verification
- Real time clock
- Various soft sectored mini floppy diskette formats

ONLY **$995.00** *single quantity price includes WAVE MATE'S enhanced C-BIOS.*



The Wave Mate "BULLET," fast, compact and powerful, is a completely integrated Z-80A, CP/M based microcomputer system packed in an attractive dual mini floppy drive enclosure. Connect any serial terminal and Centronics compatible printer and you are in business with an unbeatable PRICE/PERFORMANCE ratio.

WAVE MATE INC.

Circle 65 on inquiry card.

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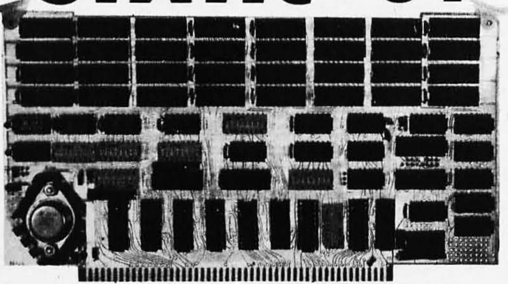
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California Digital

Post Office Box 3097 B • Torrance, California 90503

California Digital STATIC • 64



RELIABILITY OF STATIC ... PRICE OF DYNAMIC

Sixteen Bit Memory

$595

February Price $850

30% Price Reduction

Utilizing the new Hitachi 6167/2167 ram chip, the Static 64 is the most current technology available is S-100 memory products.
24 bit extended addressing, 8 or 16 bit data paths along with 16 bit request and acknowledge make this unique board completely compatable with the IEEE 696 S-100 buss standard.

The Static 64 has been engineered to allow each 16K segment of memory to be bank selectable supporting multiuser systems. Other selectable features allow the board to fully integrate with all current bank selecting schemes including Cromex and Alpha-Micro. Operates with all 16 bit computers including Seattle Computers, Tecmar and Lomas. Designed for DMA operations at clock frequencies in excess of 10 MHz. Standby power consumption less than one Amp.

To add to the total integrity of the product, each board is subjected to extensive high temperature burn-in and test procedures. CAL-6400

ZENITH $119

GREEN PHOSPHOR MONITOR

The new Zenith ZVM-121 monitor features a P-31 green phosphor tube along with 15 MHz bandwidth.

Switch selectable for 40 and 80 character per line screen formats.

Accepts composite video and is fully compatable with 80 column Apple cards.
VDM-121 20 lbs.



EPSON MX80

$450

Epson MX80FT friction/tr	$595.00
Epson MX100 132 column	
Graftrax 80 option	70.00
Apple I/O & cable (8131)	129.00
Serial interface (8141)	79.00
Serial Inter., 2K buf. (8151)	145.00
Cable for TRS-80	35.00
IEEE 488 interface (8161)	65.00
Replacement head	45.00
Replacement Ribbon	14.00
Paper 3500 sheets 9 1/2"	35.00

NEC PC-8023A

$535

Dot-matrix, bi-directional, logic-seeking, friction or tractor feed, impact printer. Complete graphics, upper and lower case ASCII, Greek, mathematics along with the ability to print dot graphic screen images directly onto paper.

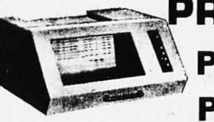
Proportional spacing and 132 column compressed print make this low cost machine the best value in todays printer market.



IBM 3101 Display Terminal

IBM Direct Price $1395

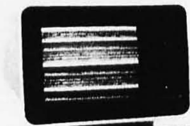
California Digital discount price $1295



PRINTRONIX

P-300 $4500

P-600 $6150





AMPEX DIALOGUE 80

REDUCED PRICE

$795

New from the Ampex Corporation. The Dialogue 80 features removable keyboard, displayable two pages (four optional) dual program keys, half intensity protected fields and status line. Transmits data either block, line or character mode. Excellent value. VDT-D80 shipping 47 lbs.

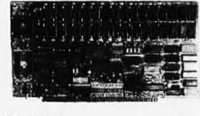
ACCESSORIES FOR THE APPLE COMPUTER

CALIFORNIA COMPUTER SYSTEMS	
Arithmetic Processor 7811 B/C	$319
Asynchronous serial interface 7710	129
Centronics Interface card 7728	95
12K PROM Module 7114	69
Calender/Clock, Bat. back-up 7424	99
Parallel Interface 7720A	99
Programable Timer 7740A	99
Analog/Digital converter 7470A	99
MICROSOFT PRODUCTS	
Apple to Z-80 CPU card	379
D. C. HAYES PRODUCTS	
Micromodem for Apple	319
COMPUTER STOP PRODUCTS	
Double Vision / 80 Column Video	250
INTERACTIVE STRUCTURES	
16 Channel A/D card AIO/2	275

MOUNTAIN COMPUTER PRODUCTS	
Intro X-10 system for BSR	$239
Intro X-10 card only	165
16 channel AD/DA 8 bit	319
Apple Clock battery back-up	225
Supertalker SD200	245
ROM Plus with filter	165
ROM Writer/Programmer	149
APPLE BRAND PRODUCTS	
Apple Language card	450
Floppy disk with controller	560
Floppy disk without controller	495
Apple parallel interface	175
SSM MICROCOMPUTER	
Dual serial parallel interface AIO	
SORRENTO VALLEY ASSOCIATES	
8" floppy controller (Pascal)	360

S-100 BOARDS

Assembled • Tested • Burned-in



CPU BOARDS

Calif. Computer 2810A Z-80 DMA, 4MHz	BDC-C2810	$250
Godbout Z-80 24 bit, 4MHz	BDC-GZ80	239
Godbout 8085/8088 dual 16 bit processor	BDC-G88	375
Measurement Systems Z-80 4 serial 2 parallel real time clock, 8 vector	BDC-MZ80	395
SD Systems SBC-200 Z-80 with serial & parallel I/O ports	BDC-SBC2	385
Teletek FDC-1 single board CPU & floppy disk controller plus I/O	BDC-FDC1	695

MAINFRAMES

Calif. Computer 2200A 12 slot & power supply	ENM-C2200	
TEI 12 slot table	ENM-T12	
TEI 22 slot table	ENM-T22	
Godbout mainfrm.	ENM-GMF	

MEMORY BOARDS

Calif. Computer 2065A 64K dyamic memory	BDM-C2065	
Calif. Computer 2016 16K static memory	BDM-C2016	259
Calif. Computer 2032 32K static memory	BDM-C2032	585
Godbout Ram 17 64K static memory 16 bit	BDM-G17	1025
SD Systems Expandoram II 16K dynamic	BDM-EX16	295
64K dynamic	BDM-EX64	375
Measurement Systems DMB6400 for Alpha Micro	BDM-M6400	685

EPROM BOARDS

Digital Research 32K, 2716 proms extra	BDM-DP32	99
SD Systems Prom-100 programmer	BDM-P100	250

FLOPPY DISK CONTROLLER

Calif. Computer 2422A with 2.2 CPM	BDF-C2422	329
Godbout "Disk One" features the NEC 765 controller, DMA arbitration	BDF-GD1	395
Measurement Systems 765 chip, single & double density. Error recovery	BDF-MF	419
SD Systems Versafloppy II double density	BDF-VF2	419
Tarbell D/D	BDF-TF2	419
Morrow Design Disk Jockey I single density	BDF-DJ1	195
Morrow Design Disk Jockey II double density	BDF-DJ2	345

INTERFACE BOARDS

Calif. Computer 2718 I/O 2 serial/2 par'l	BDT-C2718	
Morrow Designs Switchboard 2 serial/4 par'l	BDT-MSB	219
Morrow Designs Multiboard 3 serial/3P. +++	BDT-MMB	275
Godbout Interfacer One 2 serial/2 par'l	BDS-GB1	199
Godbout Interfacer Two 1 serial/3 par'l	BDS-GB2	199

SPECIALITY BOARDS

QT Computer real time clock/calendar	BDS-QCK	135
Artec Elec. Wire wrap prototype board	BDS-AWW	25
Artec Elec. General Purpose proto board	BDS-AGP	25
Godbout Spectrum color board	BDS-GSC	295
D. C. Hayes S-100 Micromodem	BDS-HM1	350
Mullen Products extender board & logic probe kit	BDS-MTB1	49
Mullen Products Opto-contro board kit	BDS-MOC	139

PRINTERS

Epson MX80	PREMX80	$475
Epson MX80FT	PREMX80F	595
Epson MX100	PREMX100	
Anadex 9500	PRA9500	1295
Anadex 9501	PRA9501	1295
Anacom 150	PRA150	1075
IDS Paper Tgr.	PRG460G	1095
IDS Tiger 560	PRG560G	1350
Diablo 630	PRD630	2150
Diablo 1650	PRD1650	2850
Diablo 1640	PRD1640	2496
Datasouth 180	PRD180	1350
Printronix 300	PRP300	4500
Printronix 600	PRP600	6150
NEC/Sellum 1	PRN5510ps	2695
NEC/Sm 16K	PRN5516ps	2795
TEC/Starwrit.	PRV300	1395
Okidata 80	PRO80	419
Okidata 82	PRO82	619
Okidata 83	PRO83	895
Teletype 43K	PTT4320K	1095
Texas Ins. 810	PRT810B	1450
Tex. Ins 810C	PRT810C	1795
Centronics 730	PRC730P	529
Centronics 737	PRC737P	695
Centronics 739	PRC739P	795
Centrnx 704-9	PRC704-9	
Centrnx.704-11	PRC704-11	

VIDEO TERMINALS

ADDS Viewpoint	VDT-RVP	595
ADDS Regent 25 numeric cluster	VDT-R25	850
ADDS Regent 30 25th status line	VDT-R30	950
ADDS Regent 40 limited graphics	VDT-R40	1195
ADDS Regent 60 Block mode	VDT-R60	1495
Ampex Dialouge 80 two page, detatch	VDT-D80	
Digital Equipment VT-100	VDT-V100	1595
Digital Equipment VT-132	VDT-V132	1895
IBM 3101-10 character mode green	VDT-3101	1195
IBM 3101-20 block mode	VDT-31012	1395
Visual 200	VDT-V200	995
Televideo 910C (new)	VDT-T910	595
Televideo 912C	VDT-T912	665
Televideo 920C	VDT-T920	745
Televideo 950C detatchable keybd.	VDT-T950	985
Zenith Z-19	VDT-Z-19	

SYSTEMS



HEWLETT PACKARD HP 85 COMPUTER

BELOW OUR COST

$2295



apple 48K Memory $1150

VIDEO MONITORS



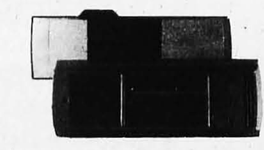
BMC KG-12C 20 MHz P31 green phosphor	$169
NEC grn. 1201	189
Zenith grn ZVM121	119
BMC color composit	339
Zenith color 13"	395
NEC RGB 1202DH	895

EPROM ERASER

Ultra Vilot Products

$65

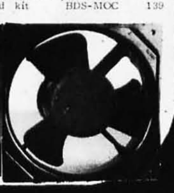
UVP-11E



Rotron Muffin Fan

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115 VAC. 7 Watts WR2A1
Factory fresh Muffin fans
NOT pull-outs. EMF-4M





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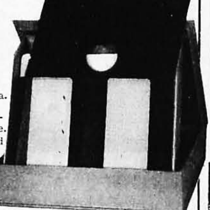
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Your Choice SCOTCH MEMOREX VERBATIM

	Soft Sector	10 Sector	16 Sector	
SCOTCH	744-0	744-10	744-16	$26.50
MEMOREX	3401	3403	3405	26.50
VERBATIM	525-01	525-10	NA	26.50
DYSAN	104/1	107/1	NA	39.50
Single Side Double Density				
DYSAN	104/1D	107/1D	NA	45.00
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SCOTCH	745-0	745-10	745-16	42.50
DYSAN	104/2D	107/2D	NA	49.50
DYSAN 96	204/2D	NA	NA	59.50

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MEMOREX	3060	29.50	MEMOREX	3090	35.00
DYSAN	3740/1	39.50	DYSAN	3740/D	57.50
Thirty Two Sector			**Double side Double Density**		
SCOTCH	740-32	29.50	SCOTCH	743-0	47.50
			MEMOREX	3114	39.50
			DYSAN	3740/2D	65.00

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Plastic Library Cases 5¼ & 8"	2.95
Diskette Flip Tubs fifty diskettes 5¼"	24.95
Diskette Flip Tubs fifty diskettes 8"	29.95

PLEASE PHONE FOR VOLUME PRICING.



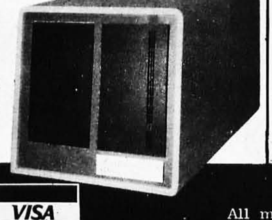
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BSR Timer eight channel	$65.00	Appliance Module 500 W.	$13.95
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MEMORY

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4164 100+	2167 70ns.
16K DYNAMIC $2.10	**2716 EPROM $4.95**
4116 100+ $1.85	100+ $4.50 1K+ $4.00



2732 EPROM SALE $7.95

STATIC

		ea.	32+	100+	1K+
21L02	1K	1.19	1.09	1.05	.99
2114	300ns.	2.95	2.75	2.50	1.99
4044-4	450ns.	4.50	4.19	4.00	3.75
4044-2	250ns.	4.95	4.65	4.50	4.25
6116	16k 24 pin	7.95	7.50	6.75	6.45
2167/6167	20 pin	11.95	10.75	9.65	9.25

EPROM

2708	450ns.	3.95	3.50	3.25	3.00
2716	5V.	4.95	4.00	3.75	3.60
2716	tri-volt	8.50	7.95	7.65	7.25
2732	Intel/Hitac.	7.95	7.50	7.00	6.65
2532	Texas Inst	12.95	11.50	10.00	9.50
2764	64K Eprom	29.95	27.00	25.00	23.50



direct connect MODEM

Your Choice $169

Direct connect modems eliminate loss of information due to the carbon compression associated with acoustic modems. Choose either of these two great units.

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Novation "D" Cat connects to most of the new "Bell" modular handsets. Ideal for multiple line office telephones. Requires external A.C. power. MOD-DCAT 2 Lb.

SWITCHES

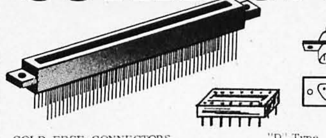
DIP SWITCHES

pos.	ea.	100+	1K+
4	.88	.75	.69
7	.99	.83	.79
8	1.05	.91	.87
12	1.19	.99	.91

TOGGLE

		ea.	100+
7101	on/on	1.19	.98
7103	on/off/on	1.39	1.19
7107	mnt. on	1.39	1.19
7108	mnt. on	1.39	1.19
7205	dpdt mnt	1.85	1.65

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Sullins Hi-Rel. W/W	5.35	4.90
Sullins/Altair .140"	4.95	4.50
.156" Centers (standard)		
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36/72 Digital Group S/T	5.95	5.50
36/72 Digital Group W/W	6.60	6.15
43/86 Motorola 6800 S/T	6.60	6.15
43/86 Moto. 6800 W/W	7.00	6.85

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	Low Profile each	Low Profile 100+	Wire Wrap each	Wire Wrap 100+
8 pin	$.10	$.09	$.46	$.41
14 pin	.10	.09	.45	.41
16 pin	.12	.11	.50	.45
18 pin	.15	.13	.68	.61
24 pin	.26	.24	.94	.87
40 pin	.42	.40	1.60	1.47

"D" Type	each	10-24	25+
DE9P male	$1.60	$1.40	$1.30
DE9S female	2.25	2.00	1.90
DE hood	1.50	1.35	1.20
DA15P male	2.35	2.15	2.00
DA15S female	3.25	3.10	2.90
DA hood 2/P	1.60	1.35	1.30
DB25P male	2.50	2.35	2.25
DB25S female	3.35	3.15	3.05
DB hood 2/P	1.35	1.15	1.05
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DD50 hood 2/P	2.60	2.40	2.10
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20/40 TRS-80	5.65	5.05	4.70
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NEW OLIVETTI 801 Eight Inch Disk Drive $295

		ONE	TWO	TEN
★ OLIVETTI 801	single	$319	309	295
★ OLIVETTI 802/851	double	425	419	410
SHUGART 801/R	single	395	385	375
SHUGART 851/R	double	525	495	475
QUME DATA TRACK 8	double	525	495	475

★ The 8" Olivetti drives are aprox. ½" wider than the Shugarts.

Five Inch Disk Drives

OLIVETTI 501/400	single	199	185	175
OLIVETTI 502/451	double	235	225	215

Upon request, all drives are supplied with power connectors and one manual per order.

230 volt 50Hz. 8" add $50.00 per drive.



$995 *Eight Inch Subsystem*

Two Olivetti 801 disk drives with power supply, 4" exhaust fan complete in dual enclosure with all necessary power cables. Documentation included. 50 Lbs. CAL-2801

Signal cable add $35.00 WCA-650D

Same as above but with:

Shugart 801R	MSD2801	$1195	Olivetti 802	CAL2802	$1250
Shugart 851R	MSD2851	1450	Qume DT8	MSD8DT	1450

SPECIAL $895

Volumn Pricing Upon Request

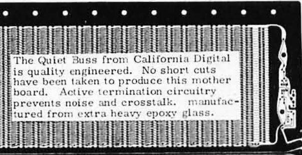
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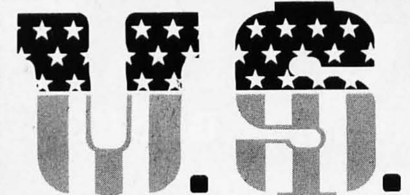
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SHUGART – SIEMANS – CDC 8"				
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+5V @ 2A	–5V @ .5A	+24V @ 3A	US-206	69.00
+5V @ 3A	–5V @ .6A	+24V @ 5A	US-162	89.00
+5V @ 1.7A	–5V @ 1.5A	+24V @ 2A	US-272	69.00
+5V @ 2A	+12V @ .4A	–12V @ .4A	US-HTAA	37.50



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- EPSON MX 80 .... CALL
- EPSON MX 100 ..... CALL
- Anadex 9501 .... $1,235.00 Graphic Printer

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- Shugart 851's — $575.00
- Qume DT-8's — $540.00
- Shugart 400's — $255.00
- Tandom 5¼ — $255.00
- Qume DT5 5¼ — $350.00 DSDD 48TPI

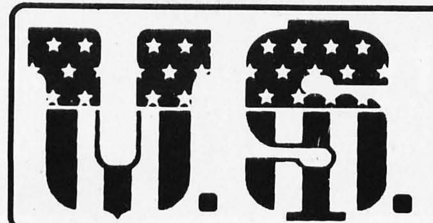
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- Televideo 912C — $665.00
- Televideo 920C — $720.00
- Televideo 950 — $950.00
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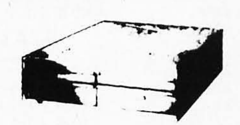
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4116-200ns **8/15.95**

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TMS2516	2048 x 8	(5V) (450ns)	6.95	5.95
2716	2048 x 8	(5V) (450ns)	5.50	4.95
2716-1	2048 x 8	(5V) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5V) (450ns)	12.95	11.95
2732	4096 x 8	(5V) (450ns) (200ns)		CALL
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				100 pcs
4027	4096 x 1	(250ns)	2.50	2.00
4116-120	16,384 x 1	(120ns)	8/29.95	CALL
4116-150	16,384 x 1	(150ns)	8/18.95	1.95
4116-200	16,384 x 1	(200ns)	8/15.95	1.80
4116-300	16,384 x 1	(300ns)	8/14.95	1.75
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21L02-4	1024 x 1	(LP) (450ns)	1.29	1.15
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1.8432	4.95
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2.4576	3.95
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4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
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74LS02	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS05	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS08	.35	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS10	.25	74LS96	.95	74LS189	9.95	74LS365	.95
74LS11	.35	74LS107	.40	74LS190	1.00	74LS366	.95
74LS12	.35	74LS109	.40	74LS191	1.00	74LS367	.70
74LS13	.45	74LS112	.45	74LS192	.85	74LS368	.70
74LS14	1.00	74LS113	.45	74LS193	.95	74LS373	.99
74LS15	.35	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS20	.25	74LS122	.45	74LS195	.95	74LS377	1.45
74LS21	.35	74LS123	.95	74LS196	.85	74LS378	1.18
74LS22	.25	74LS124	2.99	74LS197	.85	74LS379	1.35
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74LS47	.75	74LS151	.75	74LS251	1.30	74LS669	1.89
74LS48	.75	74LS153	.75	74LS253	.85	74LS670	2.20
74LS49	.75	74LS154	2.35	74LS257	.85	74LS674	9.65
74LS51	.25	74LS155	1.15	74LS258	.85	74LS682	3.20
74LS54	.35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	.35	74LS157	.75	74LS260	.65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	.45	74LS161	.95	74LS275	3.35	74LS689	2.40
74LS75	.50	74LS162	.95	74LS279	.55	81LS95	1.69
74LS76	.40	74LS163	.95	74LS280	1.98	81LS96	1.69
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74C08	.35	74C903	.85	4022	1.15	14410	12.95
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74C192	2.25	4013	.45	4078	.30	4724	1.50
74C193	2.25	4014	.95	4081	.30	80C07	.95
74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
74C221	2.25	4017	1.15	4086	.95	80C97	.95
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LM747	.79
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LM1414	1.59
LM1458V	.69
LM1488	.99
LM1489	.99
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LM3900	.59
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LM3914	3.95
LM3915	3.95
LM3916	3.95
75451V	.39
75452V	.39
75453V	.39

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74S00	.44	74S74	.69	74S163	3.75	74S257	1.39
74S02	.48	74S85	2.39	74S168	4.65	74S258	1.49
74S03	.48	74S86	1.44	74S169	5.44	74S260	1.83
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S275	19.95
74S08	.48	74S114	1.50	74S181	4.47	74S280	2.90
74S09	.98	74S124	2.77	74S182	2.95	74S287	4.75
74S10	.69	74S132	1.24	74S188	3.95	74S288	4.45
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74S65	1.25	74S162	3.70	74S253	7.45	74S570	7.80
						74S571	7.80

7400 SERIES

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7401	.19	7453	.23	74141	.65	74190	1.15
7402	.19	7454	.23	74142	2.95	74191	1.15
7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

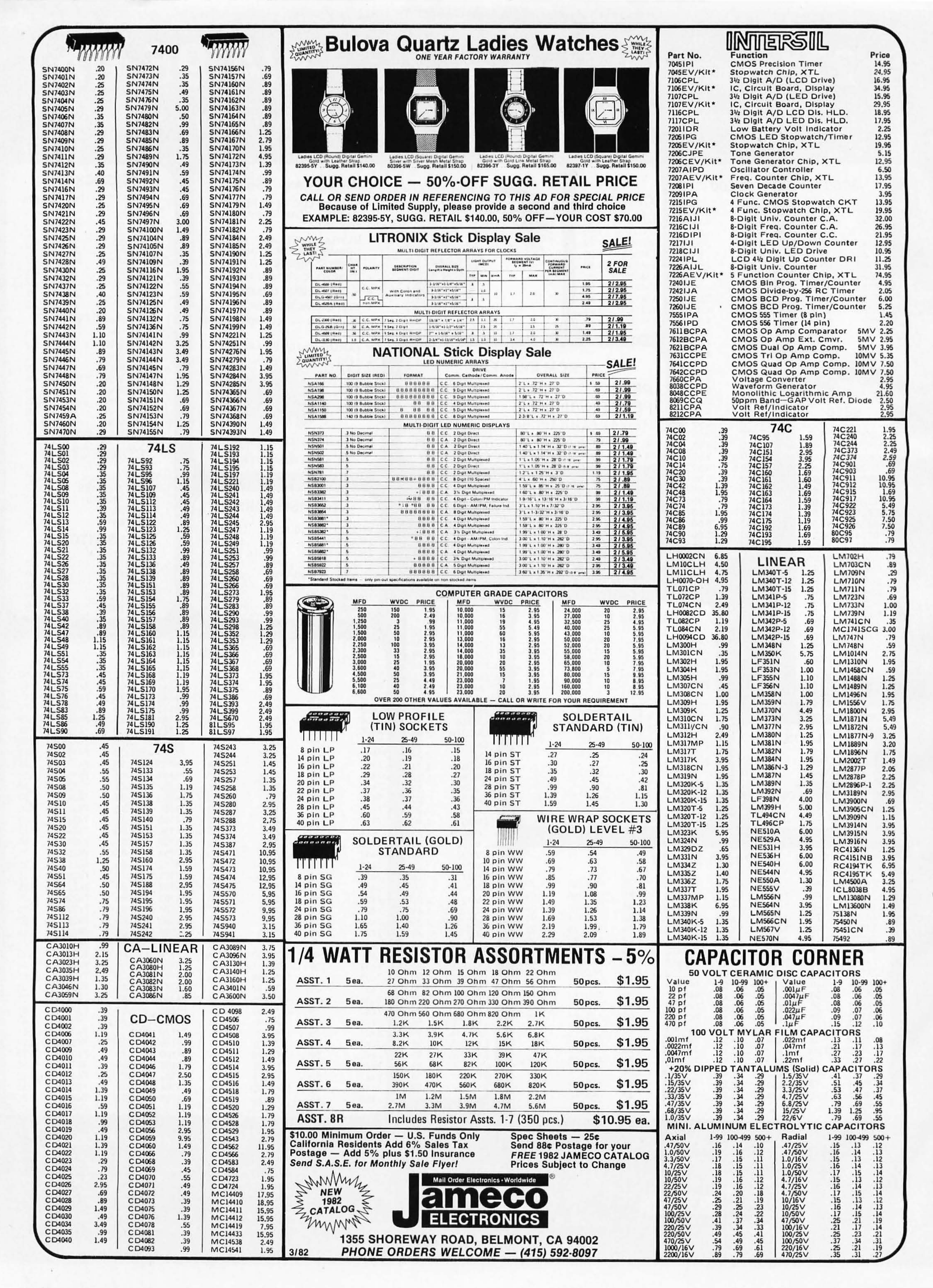
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SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
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SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
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SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
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SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

Part	Price	Part	Price	Part	Price
74LS00	.29			74LS192	1.15
74LS01	.29	74LS92	.75	74LS193	1.15
74LS02	.29	74LS93	.75	74LS194	1.15
74LS03	.29	74LS95	.99	74LS195	1.15
74LS04	.35	74LS96	1.15	74LS197	1.19
74LS05	.35	74LS107	.45	74LS221	1.19
74LS08	.35	74LS109	.45	74LS240	1.49
74LS09	.35	74LS112	.45	74LS241	1.49
74LS10	.35	74LS113	.49	74LS242	1.49
74LS11	.39	74LS114	.49	74LS243	1.49
74LS12	.35	74LS122	.89	74LS244	1.49
74LS13	.59	74LS123	1.25	74LS245	2.95
74LS14	.99	74LS125	.59	74LS247	1.19
74LS15	.35	74LS126	.59	74LS248	1.19
74LS20	.35	74LS132	.99	74LS249	1.19
74LS21	.35	74LS133	.89	74LS251	.99
74LS22	.35	74LS136	.49	74LS253	.99
74LS26	.35	74LS138	.89	74LS257	.89
74LS27	.35	74LS139	.89	74LS258	.69
74LS28	.35	74LS151	.89	74LS260	.69
74LS30	.35	74LS153	.89	74LS266	.69
74LS32	.35	74LS154	1.75	74LS273	1.95
74LS33	.59	74LS155	.89	74LS279	.89
74LS37	.45	74LS156	.89	74LS283	.89
74LS38	.39	74LS157	.89	74LS290	.99
74LS40	.35	74LS158	.89	74LS293	.99
74LS42	.89	74LS160	1.15	74LS298	1.25
74LS47	.89	74LS161	1.15	74LS352	1.29
74LS48	1.15	74LS162	1.15	74LS353	1.29
74LS49	1.15	74LS163	1.15	74LS365	.69
74LS51	.35	74LS164	1.15	74LS366	.69
74LS54	.35	74LS165	1.15	74LS367	.69
74LS55	.35	74LS168	1.19	74LS368	.69
74LS73	.45	74LS169	1.19	74LS373	1.95
74LS74	.45	74LS170	1.95	74LS374	1.95
74LS75	.59	74LS173	.99	74LS375	.89
74LS76	.45	74LS174	.99	74LS386	.69
74LS78	.49	74LS175	.99	74LS393	2.49
74LS83	.89	74LS181	2.95	74LS399	2.49
74LS85	1.25	74LS190	1.25	74LS670	2.49
74LS86	.49	74LS191	1.25	81LS95	1.95
74LS90	.69			81LS97	1.95

74S

Part	Price	Part	Price	Part	Price
74S00	.45			74S243	3.25
74S02	.45			74S244	3.25
74S03	.45	74S124	3.95	74S251	1.45
74S04	.55	74S133	.55	74S253	1.45
74S05	.55	74S134	.69	74S257	1.35
74S08	.50	74S135	1.19	74S258	1.35
74S09	.50	74S136	1.75	74S260	.79
74S10	.45	74S138	1.35	74S280	2.95
74S11	.45	74S139	1.35	74S287	3.25
74S15	.45	74S140	.79	74S288	2.75
74S20	.45	74S151	1.35	74S373	3.49
74S22	.45	74S153	1.35	74S374	3.49
74S30	.45	74S157	1.35	74S387	2.95
74S32	.55	74S158	1.35	74S471	10.95
74S38	1.25	74S160	2.95	74S472	10.95
74S40	.50	74S174	1.59	74S473	10.95
74S51	.45	74S175	1.59	74S474	12.95
74S64	.50	74S188	2.95	74S475	12.95
74S65	.50	74S194	1.95	74S570	5.95
74S74	.75	74S195	1.95	74S571	5.95
74S86	.79	74S196	1.95	74S572	9.95
74S112	.79	74S240	2.95	74S573	9.95
74S113	.79	74S241	2.95	74S940	3.15
74S114	.79	74S242	2.25	74S941	3.15

CA–LINEAR

Part	Price	Part	Price	Part	Price
CA3010H	.99			CA3089N	3.75
CA3013H	2.15	CA3060N	3.25	CA3096N	3.95
CA3023H	3.25	CA3080H	1.25	CA3130H	1.39
CA3035H	2.49	CA3081N	2.00	CA3140H	1.25
CA3039H	1.35	CA3082N	2.00	CA3160H	1.25
CA3046N	1.30	CA3083N	1.60	CA3401N	.59
CA3059N	3.25	CA3086N	.85	CA3600N	3.50

CD–CMOS

Part	Price	Part	Price	Part	Price
CD4000	.39			CD 4098	2.49
CD4001	.39			CD4506	.75
CD4002	.39			CD4507	.99
CD4006	1.19	CD4041	1.49	CD4508	3.95
CD4007	.25	CD4042	.99	CD4510	1.39
CD4009	.49	CD4043	.89	CD4511	1.29
CD4010	.49	CD4044	.89	CD4512	1.49
CD4011	.39	CD4046	1.79	CD4514	3.95
CD4012	.25	CD4047	2.50	CD4515	2.95
CD4013	.49	CD4048	1.35	CD4516	1.49
CD4014	1.39	CD4049	.49	CD4518	1.79
CD4015	1.19	CD4050	.69	CD4519	.89
CD4016	.59	CD4051	1.19	CD4520	1.29
CD4017	1.19	CD4052	1.19	CD4526	1.79
CD4018	.99	CD4053	1.19	CD4528	1.79
CD4019	.49	CD4056	2.95	CD4529	1.95
CD4020	1.19	CD4059	9.95	CD4543	2.79
CD4021	1.39	CD4060	1.49	CD4562	11.95
CD4022	1.19	CD4066	.79	CD4566	2.79
CD4023	.29	CD4068	.39	CD4583	2.49
CD4024	.79	CD4069	.45	CD4584	.75
CD4025	.23	CD4070	.55	CD4723	1.95
CD4026	2.95	CD4071	.49	CD4724	1.95
CD4027	.69	CD4072	.49	MC14409	17.95
CD4028	.89	CD4073	.39	MC14410	18.95
CD4029	1.49	CD4075	.39	MC14411	15.95
CD4030	.49	CD4076	1.39	MC14412	15.95
CD4034	3.49	CD4078	.55	MC14419	7.95
CD4035	.99	CD4081	.39	MC14433	15.95
CD4040	1.49	CD4082	.39	MC14538	2.49
		CD4093	.99	MC14541	1.95

Bulova Quartz Ladies Watches

WHILE THEY LAST!

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Ladies LCD (Round) Digital Gemini Gold with Leather Strap 82395-5Y . . Sugg. Retail $140.00

Ladies LCD (Square) Digital Gemini Silver with Silver Mesh Metal Strap 80396-5W . . Sugg. Retail $150.00

Ladies LCD (Round) Digital Gemini Gold with Gold Link Metal Strap 82396-3Y . . Sugg. Retail $165.00

Ladies LCD (Square) Digital Gemini Gold with Leather Strap 82397-1Y . . Sugg. Retail $150.00

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LITRONIX Stick Display Sale

WHILE THEY LAST! SALE!

MULTI-DIGIT REFLECTOR ARRAYS FOR CLOCKS

PART NUMBER/ COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE Length x Height x Depth	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) If = 20mA TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE	2 FOR SALE
DL-4500 (Red)	.50	C.C. MPX	With Colon and Auxiliary Indicators	3-1/16"x1-1/4"x5/16"	.8	.5	10	1.7	2.0	30	1.95	2/2.95
DL-4507 (Red)				3-1/16"x1"x5/16"	—	1.0					1.75	2/2.95
DLG-4507 (Grn)		C.C. non-MPX		3-1/16"x1"x5/16"	.8	.5					4.95	2/7.95
DL-4520A (Red)				3-1/16"x1"x5/16"							2.49	2/2.95

MULTI-DIGIT REFLECTOR ARRAYS

PART NUMBER/ COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE	TYP	MIN	@mA	TYP	MAX	MAX	PRICE	2 FOR SALE
DL-2300 (Red)	.30	C.C. MPX	7 Seg. 2-Digit RHDP	13/16" x 7/8" x 1/4"	2.5	1.1	20	1.7	2.0	30	.79	2/.99
DLG-2535 (Grn)	.50	C.A. MPX	9 Seg. 2 Digit	1-5/16"x1-1/2"x5/16"		2.5	20		3.5	25	.89	2/1.19
DL-4509 (Red)	.50	C.C. MPX	9 Seg. 4 Digit RHDP	2" x 1-5/16" x 5/16"	.8	.5	10	1.7	2.0	30	1.49	2/1.95
DL-3130 (Red)	1.0	C.A. MPX	7 Seg. 3 Digit RHDP	2-1/4"x1-13/16"x5/16"	1.5	1.0	10	3.4	4.0	30	2.25	2/3.49

NATIONAL Stick Display Sale

LIMITED QUANTITY! SALE!

LED NUMERIC ARRAYS

PART NO.	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE
NSA166	100 (9 Bubble Stick)	888888	C.C. 6 Digit Multiplexed	2"L x .72"H x .27"D	$ .59	2/.99
NSA198	100 (9 Bubble Stick)	888888888	C.C. 9 Digit Multiplexed	2"L x .72"H x .27"D	.69	2/.99
NSA298	100 (9 Bubble Stick)	888888888	C.C. 9 Digit Multiplexed	1.98"L x .72"H x .27"D	.69	2/.99
NSA1140	100 (9 Bubble Stick)	88 88	C.C. 4 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.79
NSA1150	100 (9 Bubble Stick)	8 88 88	C.C. 5 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.59
NSA1588	140 (9 Bubble Stick)	88888888	C.C. 8 Digit Multiplexed	2-3/8"L x .72"H x .27"D	.69	2/1.19

MULTI-DIGIT LED NUMERIC DISPLAYS

PART NO.	DIGIT SIZE (RED)	FORMAT	DRIVE	OVERALL SIZE	PRICE	SALE
NSN373	.3 No Decimal	88	C.C. 2 Digit Direct	.80"L x .80"H x .225"D	$ .69	2/.79
NSN374	.3 No Decimal	88	C.A. 2 Digit Direct	.80"L x .80"H x .225"D	.79	2/.99
NSN501	.5 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D (7/16" pins)	.89	2/1.49
NSN502	.5 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D (7/16" pins)	.89	2/1.49
NSN581	.5	88	C.C. 2 Digit Multiplexed	1"L x 1.05"H x .28"D (7/16" pins)	.99	2/1.79
NSN583	.5	88	C.C. 2 Digit Direct	1"L x 1.05"H x .28"D (3/8" pins)	.99	2/1.79
NSN781	.7	88	C.C. 2 Digit Multiplexed	1.2"L x 1.25"H x .3"D	1.19	2/1.95
NSB2100	.3	88*88=8888	C.C. 8 Digit (10 Spaces)	4"L x .60"H x .250"D	.75	2/.89
NSB3001	.3	8888	C.C. 4 Digit Multiplexed	1.59"L x .85"H x .25"D (7/16" pins)	.75	2/.89
NSB3382	.3	+:888	C.A. 3½ Digit Multiplexed	1.60"L x .80"H x .225"D	.99	2/1.49
NSB3411	.3	88 88	C.C. 4 Digit – Colon/PM Indicator	1-9/16"L x 13/16"H x 3/16"D	.99	2/1.19
NSB3662	.3	*:8 *88 88	C.C. 6 Digit – AM/PM, Failure Ind.	3"L x 1.10"H x 7/32"D	2.95	2/3.95
NSB3864	.3	88888888	C.A. 8 Digit Multiplexed	3"L x 1-3/32"H x 3/16"D	2.95	2/3.95
NSB3881*	.3	8888	C.C. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB3882*	.3	8888	C.A. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB5382*	.5	+:888	C.A. 3½ Digit Multiplexed	1.99"L x 1.00"H x .28"D	3.49	2/5.95
NSB5441	.5	*88 88	C.C. 4 Digit – AM/PM, Colon Ind.	3.00"L x 1.10"H x .282"D	2.95	2/3.95
NSB5881*	.5	8888	C.C. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5882*	.5	8888	C.A. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5918	.5	+8888	C.C. 3¾ Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.49	2/3.49
NSB5922	.5	88888	C.A. 5 Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.95	2/3.49
NSB7923	.7	888888	C.C. 6 Digit Multiplexed	3.60"L x 1.35"H x .292"D (3/8" pins)	3.95	2/4.95

*Standard Stocked Items — only pin-out specifications available on non stocked items

COMPUTER GRADE CAPACITORS

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	19	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.49	40,000	25	5.95
1,500	50	2.95	11,000	60	5.95	43,000	10	5.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	73,800	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
5,500	25	4.49	23,000	7	1.95	90,000	10	8.95
6,100	40	2.49	23,000	10	2.95	160,000	10	8.95
6,600	50	4.95	23,000	20	3.95	200,000	3	12.95

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

		Values		
ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

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Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

Part	Price	Part	Price	Part	Price
74C00	.39			74C221	1.95
74C02	.39	74C95	1.59	74C240	2.25
74C04	.39	74C107	1.89	74C244	2.25
74C08	.39	74C151	2.95	74C373	2.49
74C10	.39	74C154	3.95	74C374	2.59
74C14	.75	74C157	2.25	74C901	.69
74C20	.39	74C160	1.69	74C903	.69
74C30	.39	74C161	1.60	74C911	10.95
74C42	1.39	74C162	1.49	74C912	10.95
74C48	1.95	74C163	1.69	74C915	1.69
74C73	.79	74C164	1.59	74C917	10.95
74C74	.79	74C173	1.39	74C922	5.49
74C85	1.95	74C174	1.39	74C923	5.75
74C86	.99	74C175	1.19	74C925	7.50
74C89	6.95	74C192	1.69	74C926	7.50
74C90	1.29	74C193	1.69	80C95	.79
74C93	1.29	74C195	1.59	80C97	.79

LINEAR

Part	Price	Part	Price	Part	Price
LH0002CN	6.85			LM702H	.79
LM10CLH	4.50			LM703CN	.89
LM11CLH	4.75	LM340T-5	1.25	LM709N	.29
LH0070-OH	4.95	LM340T-12	1.25	LM710N	.79
TL071CP	.79	LM340T-15	1.25	LM711N	.79
TL072CP	1.39	LM341P-5	.75	LM723N	.69
TL074CN	2.49	LM341P-12	.75	LM733N	1.00
LH0082CD	35.80	LM341P-15	.75	LM739N	1.19
TL082CP	1.19	LM342P-5	.69	LM741CN	.35
TL084CN	2.19	LM342P-12	.69	MC1741SCG	3.00
LH0094CD	36.80	LM342P-15	.69	LM747N	.79
LM300H	.99	LM348N	1.25	LM748N	.59
LM301CN	.35	LM350K	5.75	LM1014N	2.75
LM302H	1.95	LF351N	.60	LM1310N	1.95
LM304H	1.95	LF353N	1.00	LM1458CN	.59
LM305H	.99	LF355N	1.10	LM1488N	1.25
LM307CN	.45	LF356N	1.10	LM1489N	1.25
LM308CN	1.00	LM358N	1.00	LM1496N	1.95
LM309H	1.95	LM359N	1.79	LM1556V	1.75
LM309K	1.25	LM370N	4.49	LM1800N	2.95
LM310CN	1.75	LM373N	3.25	LM1871N	5.49
LM311/CN	.90	LM377N	2.95	LM1872N	5.49
LM312H	2.49	LM380N	1.25	LM1877N-9	3.25
LM317MP	1.15	LM381N	1.95	LM1889N	3.20
LM317T	1.75	LM382N	1.79	LM1896N	1.75
LM317K	3.95	LM384N	1.95	LM2002T	1.49
LM318CN	1.95	LM386N-3	1.29	LM2877P	2.05
LM319N	1.95	LM387N	1.45	LM2878P	2.25
LM320K-5	1.35	LM389N	1.35	LM2896P-1	2.25
LM320K-12	1.35	LM392N	.69	LM3189N	2.95
LM320K-15	1.35	LF398N	4.00	LM3900N	.69
LM320T-5	1.25	LM399H	5.00	LM3905CN	1.25
LM320T-12	1.25	TL494CN	4.49	LM3909N	1.15
LM320T-15	1.25	TL496CP	1.75	LM3914N	3.95
LM323K	5.95	NE510A	6.00	LM3915N	3.95
LM324N	.99	NE529A	4.95	LM3916N	3.95
LM329DZ	.65	NE531H	3.95	RC4136N	1.25
LM331N	3.95	NE536H	6.00	RC4151NB	3.95
LM334Z	1.30	NE540H	6.00	RC4194TK	6.95
LM335Z	1.40	NE544N	4.95	RC4195TK	5.49
LM336Z	1.75	NE550A	1.30	LM4500A	3.25
LM337T	1.95	NE555V	.39	ICL8038B	4.95
LM337MP	1.15	LM556N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
,01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

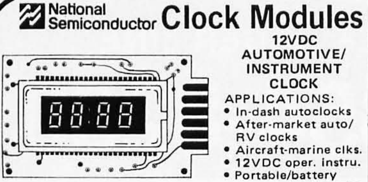
Value	1-9	10-99	100+	Value	1-9	10-99	100+
.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

Circle 202 on inquiry card.

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module (3.05"Lx1.75"Hx.98"D) . **$16.95**

CLOCK MODULES

MA1023	.7" Red Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Red Digital LED Clock/Timer	6.95
MA1002	.5" Red Digital LED Clock & Xformer	9.95
MA1010	.8" Red Digital LED Clock	7.95
MA1032	CBA .5" Digital LCD Clock	17.95
MA1043	.7" Green Digital LED Clock	8.95

TRANSFORMERS

102-P20 Xformer for MA1023, 1043 & 5036 Mods.	3.49
102-P22 Xformer for MA1026 Clock Modules	3.49
102-P24 Xformer for MA1010 Clock Modules	3.49



National Semiconductor

RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) . . . . **$2.49 each**
(8 EACH $16.95/lot) (100 EACH $195.95/lot)

MM2114N-2L 4K (200NS) Low Power . . . . **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM2147N 4K (70NS) . . . . **$4.95 each**
(8 EACH $34.95/lot) (100 EACH $419.95/lot)

MM6116P-4 16K (200NS) . . . . **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

DYNAMIC RAMS

MM4164N-20 64K (200NS) . . . . **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

MM5290N-2 16K (150NS) 4116 . . . . **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 . . . . **$1.95 each**
(8 EACH $14.95/lot) (100 each $175.00/lot)

EPROM Erasing Lamp

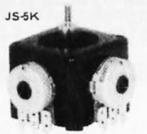


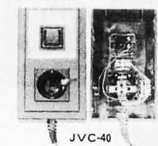
- **Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.**
- **Erases up to 4 chips within 20 minutes.**
- **Maintains constant exposure distance of one inch.**
- **Special conductive foam liner eliminates static build-up.**
- **Built-in safety lock to prevent UV exposure.**
- **Compact — only 7-5/8" x 2-7/8" x 2"**
- **Complete with holding tray for 4 chips.**

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS





JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case . . .	$4.95

MUFFIN® FAN

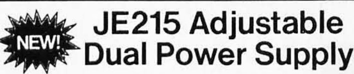


The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz.
- acoustical rating as low as NC-38
- more than 10 yrs. cont. duty at 10°C
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

Model No. MU2A1, Part No. 02821, Bearing—Sleeve, 115V, 50/60Hz, 14 Watts, 105cfm

MU2A1 . . . . $9.95 ea.



JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	8.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x40C)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	2.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	8.95
2732 Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123 (74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

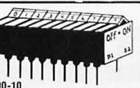
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95



2400-10

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series

THE MOST UNIQUE DIP SWITCH AVAILABLE!

MINI-DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self-wiping contact. One-piece housing and press-fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C." **• Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal**

Part No.	Pos.	Configuration	Socket	Price	Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95	2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-3	3	123	8 pin	.89 - 10/ 7.95	2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95	2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95	2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95	2400-10	10	0123456789	20 pin	1.49 - 10/13.95

JE608 PROGRAMMER

2704/2708 EPROM PROGRAMMER

GENERAL APPLICATIONS:
- **To program EPROMS 2704 and 2708.**
- **Developmental system for microcomputer circuits**
- **To read the contents of a pre-programmed EPROM**
- **To compare EPROM(s) for content differences**
- **To emulate a programmed EPROM**
- **To store program in RAMS for alterations**
- **Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.**

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel board are separate assemblies within the system.

JE608K Kit $399.95
JE608A Assembled and Tested $499.95

JE608-16K ADAPTER BOARD

FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608-16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. The adapter provides for adding an address switch for the 2^{11} bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separately to each half (1024x8) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit	**$29.95**
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation of the JE608-16K Adapter Board Kit)	**$99.95**
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	**$599.95**

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
Postage — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sale Flyer!

Spec Sheets — 25¢
Send 88¢ Postage for your *FREE* 1982 JAMECO CATALOG
Prices Subject to Change





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PHONE ORDERS WELCOME — (415) 592-8097

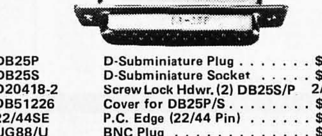
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BOOKS

National Semiconductor — Intersil — Intel

30001	**National CMOS Data Book** . . . . (640 pages) 74C, CD4000, and A/D Converters	**$5.95**
30002	**National Interface Data Book** . . . . (704 pages) DP, DS8000, DS3600, DS75000, etc.	**$5.95**
30003	**National Linear Data Book** . . . . (1376 pages) LM, LF, ADC, DAC, LH Series	**$8.95**
30004	**National Series 80 — Board Level Computer** (224 pages) . . .	**$4.95**
30005	**National TTL Logic Data Book** . . . . (624 pages) 7400, LS, L, H, S, and DM8000 Series	**$8.95**
30006	**Buy above (3) 30001,3,5 as a set**	**$19.95/lot**
30009	**Intersil Data Book** (1074 pages)	**$6.95**
010400	**Intel Component Data Catalog** . . . . Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	**$10.00**
205610	**Intel Peripheral Design Handbook** . . . . Full data sheets, appl. notes for Intel peripheral device components (644 pages)	**$7.50**

AC and DC Wall Transformers



With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-). six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$3.95

CONNECTORS

DB25P	**D-Subminiature Plug . . . .**	**$2.95**
DB25S	**D-Subminiature Socket . . . . .**	**$3.50**
D20418-2	**Screw Lock Hdwr. (2) DB25S/P**	**2/$.99**
DB51226	**Cover for DB25P/S . . . .**	**$1.75**
22/44SE	**P.C. Edge (22/44 Pin) . . . . . .**	**$2.95**
UG88/U	**BNC Plug . . . .**	**$1.79**
UG89/U	**BNC Jack . . . .**	**$3.79**
UG175/U	**UHF Adapter . . . .**	**$ .49**
SO239	**UHF Panel Recp. . . . .**	**$1.29**
PL258	**UHF Adapter . . . .**	**$1.60**
PL259	**UHF Plug . . . .**	**$1.60**
UG260/U	**BNC Plug . . . .**	**$1.79**
UG1094/U	**BNC Bulkhead Recp. . . . . . .**	**$1.29**

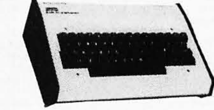
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:

- **8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)**
- **Documentation for conversion**

TRS-16K2 *150ns	**19.95**
TRS-16K3 *200ns	**15.95**
TRS-16K4 *250ns	**14.95**

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . . . . . **$ 79.95**
K62 62-Key Keyboard (Keyboard only) . . . **$ 34.95**
DTE-AK (case only — 3¼"Hx11"Wx8¾"D) **$ 49.95**

NEW! **JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT**
Provides -12VDC from incoming 5VDC . . **$9.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

Circle 202 on inquiry card.

Circle 8 on inquiry card.

BECKMAN DIGITAL MULTIMETERS

TECH 300 Digital Multimeter	$ 110 00
TECH 310 Digital Multimeter	140 00
TECH 330 Digital Multimeter	189 00
VC-201 Vinyl Carrying Case	10 00
DC-202 Deluxe Carrying Case	24 00
HV-211 High Voltage Probe	35 00
RP-221 RP Probe	35 00
CT-231 AC Current Clamp	42 00
DL-241 Deluxe Test Lead Kit	10 00
TL-242 Square Test Leads	6 00

NLS TOUCH TEST 20

Digital Multimeter	$349 95

S100 32K STATIC RAM BOARD

2 or 4 MHz Expandable uses 2114L's

16K 4 MHz Kit	$159 95
16K 4MHz A&T	217 95
32K MHz Kit	289 95
★ 32K 4 MHz A&T	★ 339 00
Bare Board	39 95
Bare Bd w/all parts less mem	99 95

8080/8085 SUPPORT

8155/8156 I/O	$ 11 95
8755 I/O w/EPROM	44 95
8202 Dyn RAM Cont	34 95
8205/74S 138 Decoder	3 95
8212 8 bit I/O	2 75
8214 Priority Int	5 25
8216 Bus Driver	2 75
8224 Clock Gen	2 95
8224 4 MHz	9 75
8226 Bus Driver	2 95
8T26 Bus Driver	2 95
8228 Sys Con	4 50
8238 Sys Con	5 50
8243 I/O Exp	9 50
8250 Asyn Com	15 95
8251 Prog I/O	6 95
8253 Int Timer	12 95
8255 Prog I/O	4 50
8257 Prog DMA	9 95
8259 Prog Int	9 95
8275 CRT Con	29 95
8279 Prog Keyboard	9 95

Z80 SUPPORT

Z80-PIO	2 5 MHz	$ 6 75
Z80A-PIO	4 0 MHz	9 95
Z80-CTC	2 5 MHz	6 75
Z80A-CTC	4 0 MHz	9 95
Z80-DMA	2 5 MHz	19 95
Z80A-DMA	4 0 MHz	29 95
Z80-SIO/0	2 5 MHz	24 95
Z80A-SIO/0	4 0 MHz	29 95
Z80-SIO/1	2 5 MHz	24 95
Z80A-SIO/1	4 0 MHz	29 95
Z80-SIO/2	2 5 MHz	24 95
Z80A-SIO/2	4 0 MHz	29 95

4K STATIC RAM SELL-OFF

for Z80 based systems

★ Zilog 6104-4 4Kx1 450ns	★ $1 49

PROTO BOARDS

PB-6	$ 19 95
PB-100	21 00
PB-101	28 00
PB-102	34 00
PB-103	59 00
PB-104	77 00
PB-203	130 00
PB-203A	170 00
PB-203A Kit	140 00

PROTO CLIPS

PC-14	14 Pin	$ 3 25
PC-16	16 Pin	3 50
PC-24	24 Pin	8 50
PC-40	40 Pin	13 95

6800 SUPPORT

6810 128x8 RAM	$ 4 75
6820	6 50
6821	6 50
6828 Priority Int	10 75
6834-1 512x8 Eprom	16 95
6845/HD46505 CRT Cont	29 95
6847 Color CRT	29 95
6850 ACIA	5 95
6852 Serial Adapter	5 95
6860 Modem	10 95
6682 Modulator	11 95
6871A 1 0MHz OSC	25 95
6880 Bus Driver	2 19
MC68488	19 95
68047	24 95

6502 SUPPORT

6520 PIA	$ 7 50
6522 Mult	11 95
6530-002 003 004 005	21 95
6532	19 95
6551	19 95

BIPOLAR PROMS

82S23/6330/5600/74S188	$ 4 25
82S115 (512x8) TS	12 95
82S123/5610/74S288 (32x8) TS	4 25
82S126/5603/74S387 (256x4) OC	4 25
82S129/5623/74S287 (256x4) TS	4 25
82S130/5604/74S570 (512x4) OC	6 50
82S131/74S571 (512x4) TS	6 95
82S137/74S573 (1024x4) TS	12 95
82S141/3624/74S474 (512x8) TS	12 95
82S147/74S472 (512x8) TS	12 95
74S471/6309 (256x8) TS	7 95

MOS PROMS

2764 (8Kx8) TS	$89 95
2732 (4Kx8) TS	16 95
2716/2516 5V (2Kx8) TS	8 95
TMS2716 ±5V, 12V	17 95
2758 5V (450ns)	7 50
2708 (450ns)	5 75
2708 (650ns)	5 25
1702A	5 75
MM5203AQ	14 50
MM5204Q	9 95

IC SPECIAL PURCHASE

82S09 64x9 RAM	$ 8 95
DP8304 Octal Driver	2 95
DAC86EX D/A Conv	6 95
MC1650 Hi Speed A/D	7 95
SN75136	46
MC10210	89
LM339	79
LM710CN	29
LM711CN	29
78M06	49
79M06	49
74157	49
74161	49
74C74	39
MC14433P 3 5 Digit A/D	13 95
ICL8211 Volt Ref	1 95
LM1850N Gr Fault	3 for 1 00
LM2900N Quad Amp	2 for 1 00
LM2917N Freq to Volt Conv	2 for 1 99
MEM4963 Mosfet Smoke Detector	7 95
27S08 32x8 PROM (IM5600)	2 95
ULN2003A 7ch dr	99
MCM14505 64 bit St RAM	6 95
MOC1003 Opto Cap (4N28)	3 for 1 00
SPX33 Opto Coup	3 for 1 00
IH5045 CMOS Sw DPST	4 50
UA3045 Trans Array	1 25
TR1402A UART	1 95
MK1007 Dyn Mem Shift Req	3 95
5318 TV Ch Disp Circuit	4 50
8700 CJ 8 bit A/D	9 95
7520/25	50
1488/1489	2 for 1 99
MC1372	8 95
MM5298-4A/B	2 95
LM377	1 25
LM380	1 25
LM387	1 25
LM4558	3 for 1 99
RC4136	2 for 1 99
RC4131	2 for 1 99
COM 5027	39 95
COM 5037	49 95
TMS 4060 4K RAM (22 Pin)	1 49
TMS 4050 4K RAM (18 Pin)	1 49
MCM 6604 4K RAM (16 Pin)	1 49

DYNAMIC RAM

416/4116 16K (16 Pin)	$ 2 49
416 200 ns Set of 8	15 95
4115 8K (16 Pin)	2 49
4050 4Kx1 (18 Pin)	4 95
4060 4Kx1 (22 Pin)	4 95
4096 4Kx1 (16 Pin)	3 95
2104 4Kx1 (16 Pin)	4 75
4027 4Kx1 (16 Pin)/UPD 414	4 95
5261	1 95
5262	1 95
5270	4 95
5280	4 95
1103	95
4008L	4 95
6605	7 95
6604	4 95
6602	1 50
64K RAM	9 95

MICROPROCESSORS

Z8001 16 bit to 8Mb	$ 110 00
Z8002 16 bit to 64K	75 00
Z80	9 95
Z80A	11 95
F-8 (3850)	16 95
2650	16 95
CD1802	9 75
8080A	4 75
8080A-4MHz	19 95
8085	14 95
8008-1	14 95
2901	9 90
2901A	14 95
TMS 9900JL	49 95
6502	9 95
6502A	16 95
IM6100	29 95
6800	11 75
6800B 2 0 MHz	19 95
6802P	14 95
8035	14 95
8039	12 95
INS 8073N	34 95
8755	49 95
8748	49 95
6809	30 00
8086	49 95
68000	129 95

CHARACTER GEN.

2513-001 (5V) Upper	$ 9 50
2513-005 (5V) Lower	10 95
2513-ADM3 (5V) Lower	14 95
MCM667 10 Ascii Shifted	12 95
MCM66740 Math Symbol	13 95
MCM66750 Alpha Control	13 45

CONNECTORS (GOLD)

DB25P (RS232)	$ 3 25
DB25S Female	3 75
Hood	1 25
Set w/Hood, Sale	7 50
22/44 W/W, S/T, KIM	2 95
43/86 W/W, S/T, MOT	6 50
50/100 S-100 Connector w/w	4 95
50/100 S-100 Connector s/t	3 95

BARE PC BOARDS

S-100 Sound Board	$ 34 95
8080A CPU	34 95
32K Static RAM (2114)	34 95
8K Eprom (2708)	24 95
2708/2716 Eprom	34 95
ACP Proto Bd	22 95
Vector 8800 Proto	22 20
Vector 8803 11 slot MB	29 95
ACP Extender w/Conn	18 95
13 Slot Mother Board (WMC)	32 95
9 Slot Mother Board (WMC)	29 95
8 Slot Mother (Expandable)	34 95
Floppy PCB (8" SHUGART)	39 95
S100 (AY5-8910) Sound Bd	34 95
Apple Sound Bd	24 95

UV "EPROM" ERASER

Model UVs-11E $79.95
Holds 4 Eproms at a time
★ **Model S-52T** ★ $325 00

16K MEMORY EXTENSION KITS

for Apple/TRS-80

★ 8 pcs 4116 16K 200/250ns ★
Specify computer $ 15 95
CALL FOR VOLUME PRICING

KEYBOARD ENCODERS

AY5-2376	$13 75
AY5-3600	13 75

MOSTEK

4K Dynamic RAM (16 Pin)
MK 4015 20 pcs @ 1 99
(Pin Equiv. MR 4027 w/ 1 ms refresh)
16K RAM SALE (4116) 100 pcs @ $1 15 ea
64K RAM SALE (4164 10 pcs @ 9 95 ea ★
16K STATIC RAM (TMM 2016) 8 pcs @ 9 95 ea

2708 EPROM

Prime 450 ns
8/29 95
2716 SALE 8/$9 95
2732 SALE 8/69 95

NEW! from Zilog

★ Z-8 CPU w/Tiny
Basic & debug program $69 95 w/data
Plus 6132 companion quasi-static RAM $34 95 ea

★ NEW LOW PRICES

8255 Prog I/O	Only $ 1 95
8259 Prog Init	Only 6 95

STATIC RAMS

	1-24	25-99	100
21L02 450ns	$ 1 30	$ 1 25	$ 99
21L02 250ns	1 59	1 55	1 15
2111	3 75	3 65	3 55
2112-1	2 95	2 85	2 65
2101-1	2 90	2 70	2 55
2114N (450ns)	3 75	3 50	3 25
2114L-250ns (4045)	6 50	5 95	5 50
2114L-450ns (4045)	4 75	4 25	3 95
4044 250ns	8 95	7 50	6 90
4044 450ns	5 95	5 95	4 75
EMM4200A	9 75	8 75	7 95
EMM4402	7 95	7 25	6 25
AMD9140/41	10 95	10 25	9 25
AMD9130/31	12 95	11 95	10 25
1101	1 95	1 75	1 25
P2125/93425 (45ns)	9 95	8 35	8 25
6518 1Kx1 CMOS	7 95	7 95	7 25
2147 Low Power 4 K Static	9 95	8 95	6 95
93415	9 95	8 95	8 50

SOCKETS

Wire Wrap 3 Level

# Pins	Lo-Pro Soldertail	Tin	Gold
8	15	$ 32	$ 45
14	19	36	59
16	20	38	62
18	24	59	84
20	29	69	99
22	24	79	1 10
24	38	85	1 20
28	43	1 10	1 49
36	58	1 25	1 59
40	60	1 40	1 89

FLOPPY DISK I/O

1771-01 8" & Minifloppy	$ 24 95
1781 Dual Floppy	29 95
1791-01 Dual Floppy	36 95
1791-02 Dual Floppy	44 95
1793 DD, DS Floppy	44 95
1797 DD DS Floppy	54 95
1691 Data Separator	18 95
2143 Clock Gen	18 95

A/D CONVERTERS

8700 8 bit Binaray	$ 13 50
8701 10 bit Binary	22 00
8703 8 bit TS	13 50
9400 Volt to Freq Conv	7 25
8750 3 1/2 Digit BCD	13 95
1408L6 6 bit	3 95
1408L8 8 bit	5 95
DAC01 D to A	5 95
DAC08	9 95
DAC 100	9 95

WAVEFORM GEN.

8038 Function Gen	$ 4 50
MC4024VCO	2 95
LM566VCO	1 95
XR2206 Function Generator	5 25

SHIFT REGISTERS

2504V	$ 1 49	MM500H	$ 50
2507V	1 49	MM5056N	2 95
2517V	1 49	MM5060N	2 95
2524V	1 49	2510A	1 95
2525	1 49	2847	4 95
2527	1 49	3341	4 95
2528	1 49	3351	17 95
2529	1 49	3357	6 95
2533	1 49	9403	24 95
3347	5 95	9408	9 95

CTS DIPSWITCHES

CTS206-2	$ 1 75	CTS206-7	$ 1 75
CTS206-4	1 75	CTS206-8	1 95
CTS206-5	1 75	CTS206 9	1 95
CTS206-6	1 75	CTS206-10	1 95

UARTS/BAUD RATE

TR1602B (5V 12V)	$ 3 95
AY51013 (5V 12V)	4 95
AY51014A/1612 (5-14V)	6 95
AY51015A/1863 (5V)	6 95
IM6402	7 95
IM6403	8 95
2350 USRT	9 95
1671B Astros	24 95
MC14411	11 95
4702	14 95
WD1941	9 95
COM 5016	16 95
INS 8250	15 95

ZERO INSERTION FORCE

16 Pin $5 50 — 24 Pin $7 50 — 40 Pin $10 25

7400

SN7400N	$ 19	SN74123N	$ 59
SN7401N	22	SN74125N	39
SN7402N	22	SN74126N	44
SN7403N	22	SN74128N	59
SN7404N	22	SN74132N	69
SN7405N	23	SN74136N	75
SN7406N	23	SN74139N	95
SN7407N	23	SN74141N	79
SN7408N	26	SN74142N	2 95
SN7409N	23	SN74143N	2 95
SN7410N	22	SN74144N	2 95
SN7411N	29	SN74145N	62
SN7412N	29	SN74147N	1 95
SN7413N	39	SN74148N	1 20
SN7414N	59	SN74150N	1 09
SN7416N	29	SN74151N	67
SN7417N	29	SN74152N	67
SN7420N	22	SN74153N	67
SN7421N	35	SN74154N	1 19
SN7422N	29	SN74155N	78
SN7423N	29	SN74156N	78
SN7425N	29	SN74157N	69
SN7426N	29	SN74158N	1 65
SN7427N	25	SN74160N	88
SN7429N	45	SN74161N	88
SN7430N	23	SN74162N	89
SN7432N	29	SN74163N	87
SN7437N	25	SN74164N	87
SN7438N	29	SN74165N	87
SN7439N	29	SN74166N	1 20
SN7440N	19	SN74167N	1 95
SN7441N	79	SN74170N	1 69
SN7442N	57	SN74172N	4 75
SN7443N	95	SN74173N	79
SN7444N	95	SN74174N	89
SN7445N	79	SN74175N	85
SN7446N	79	SN74176N	75
SN7447N	65	SN74177N	75
SN7448N	79	SN74179N	1 34
SN7450N	19	SN74180N	75
SN7451N	19	SN74181N	1 75
SN7453N	19	SN74182N	75
SN7454N	19	SN74184N	2 25
SN7459N	25	SN74185N	2 25
SN7460N	23	SN74186N	9 95
SN7470N	29	SN74188N	3 90
SN7472N	29	SN74190N	1 15
SN7473N	34	SN74191N	1 15
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ADVANCED COMPUTER PRODUCTS

Unclassified Ads

FOR SALE: BYTE, May 1978 through May 1981 (37 issues). Kilobaud Microcomputing, #11 through #29 and #37 through #54 (37 issues). Creative Computing, January 1978 through July 1981 (34 issues). onComputing, Summer 1979 through Spring 1981 (8 issues). Each issue for $1.75 or all of them for $150. I will pay postage. Joe, 3503 Berkeley Pl. NE, Albuquerque, NM 87106, (505) 266-2344.

FOR SALE: 16-column calculator printer. Works, but little documentation. $25 plus shipping (5 pounds). Hex keypad and display, obviously homemade; $20. Fifty Tri-state bipolar ROMS that decode and drive eight S-100 signals directly from Z80. No external buffering necessary. Derives sMEMR, MWRT, sINP, sOUT, pSYNC, INTA, sWO, and pWR. $6 each. Mark Derthick, 7 Fraternity Row, St. Louis, MO 63130, (314) 721-9093.

FOR SALE: Heath H-89 all-in-one microcomputer. Built in July 1981. Floppy-disk drive, 48 K programmable memory, cassette interface, HDOS 2.0 DOS, Microsoft and BH BASIC, 15 disks of club programs, and all documentation. $3000 value for $1700. Also have Heath ET-3400 trainer, EE-3401 microprocessor self-instruction course, and final exam; $195. Will pay shipping in U.S. Gary Bagby, 2520 Childs Rd., Omaha, NE 68147, (402) 731-1871.

FOR SALE: Ohio Scientific Challenger III (Model C3-S1) with three processors (6502A, 68B00, Z80A) and 56 K memory. Double-sided 8-inch floppies for 1.2 megabytes storage. CP/M operating system with FORTRAN and COBOL compilers. Manuals and documentation included. $4800. Ron Hopson, POB 7929 (N173), Philadelphia, PA 19101.

FOR SALE: Interac computer—not used, still in the package. With 16 K RAM, 2 K ROM, cassette, 1500 bps, eight colors, and sound; $284. Write for more details. Steve Buhk, 109 East Kentucky Ave., Deland, FL 32720.

FOR SALE: Centronics 730 printer, same as Radio Shack Lineprinter II. New, only tested. Full documentation. Extra ribbons. $600 UPS COD. D. Dingley, 417 Liberty St., Painesville, OH 44077, (216) 354-5759.

FOR SALE: SSM CB1A 8080 S-100 processor board with 1 K RAM, 2 K video monitor in ROM, and parallel I/O port. Assembled and tested. Virtually unused. $125. Craig Cline, 40 Creighton St., Cambridge, MA 02140, (617) 661-3966.

FOR SALE: Linear programming package for Hewlett-Packard 9825 computer. Complete package consisting of manual and three cartridges in binder. Originally cost $450 and used only a couple of times. Will sell for $125 or exchange for HP-85 software Pacs I don't have. Will also consider HP-85 ROMs. C.J. Kanak, POB 28206, Tempe, AZ 85282, (602) 968-6542.

FOR SALE: Apple II with 64 K Pascal language system, two disk drives, software, and other accessories; $2000. Zenith Z19 terminal; $600. Heath H-14 printer, assembled; $500. All items in good working order. Thomas McDonnell, 1738 Orchard Dr., Canton, MI 48188, (313) 326-3047 weekends or after 6 p.m. weekdays.

FOR SALE: Texas Instruments TI-745. Like new. Under constant maintenance by TI. Must sell. Asking $1000 or best offer. D.P. Apt. 25102 Friar Lane, Southfield, MI 48034.

FOR SALE: TEC V-300 daisy-wheel printer. Brand new. Bidirectional printing at 25 cps/136 print positions wide. Proportional spacing: 1/20-inch horizontal and 1/48-inch vertical. Centronics parallel interface. Listed at $1595; will sell for $1000 FOB. R.G. Lathrop, 810 Rush Court, Chico, CA 95926, (916) 343-7098.

FOR SALE OR SWAP: TRS-80 4 K Color Computer, pair of joysticks, and three cartridges of games. Will send in original carton via U.P.S. $325 or will swap for a Model I mini-disk drive. Jack Liskey, 360 Mae Rd., Glen Burnie, MD 21061.

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Ciarcia Wins BOMB by Remote Control

Steve Ciarcia's project on using your computer for remote control earned him first place in the December BOMB contest. Now if we could only send him the $100 cash prize by remote control. Senior editor Gregg Williams took second place with his photo essay, "The Coinless Arcade." Though Gregg is a gamesman, he's not a gambler and when playing video games he can't afford to lose because as a staff member he is ineligible for the second-place $50 prize. Third place went to William Barden Jr.'s "Color Computer from A to D, Make Your Color Computer 'See' and 'Feel' Better," the first installment in a series devoted to Radio Shack's TRS-80 Model I, Model III, and Color Computer.

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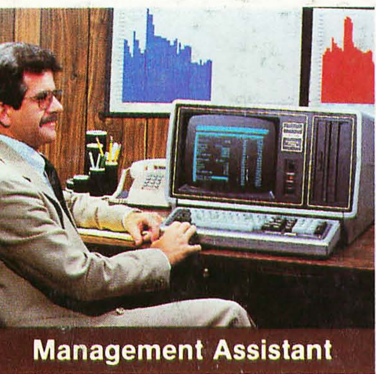
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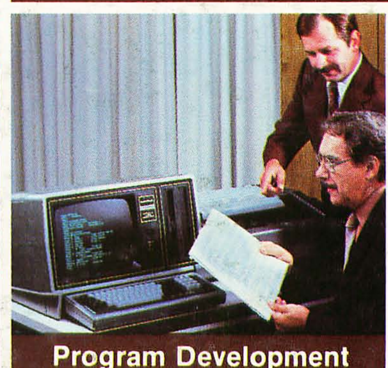


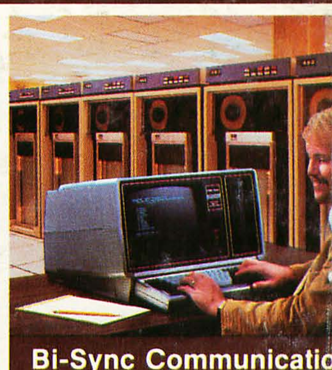
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